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ANOTHER RECORD BREAKER.

The present number of THE ELECTRICAL WORLD is the finest that has ever gone to a convention. The articles are of unusual timeliness and importance, while in number of advertisements and in volume of advertising no previous convention issue has ever reached as high a mark. The figures for the corresponding issues for the last five years—all announcements of the publishers; all "office advertising" being entirely omitted from the calculations—compare as follows:

	Pages.	Number of Advertisements.	Inches of Advertising.
March 7, 1891	42	301	2,099
February 27, 1892	52	357	2,613
March 4, 1893	56	378	2,828
March 4, 1894	76	386	3,215
February 23, 1895	84	395	3,560

THE ELECTRICAL WORLD is trying conscientiously to give manufacturers the best advertising service possible in its field at the least cost, and it is most gratifying to see from the figures quoted that manufacturers appreciate this more and more as time goes on.

ECONOMY IN THE BOILER ROOM.

The article by Lieut. Cahoon, in another column, brings out in a forcible manner the influence of the boiler room factor on the economy of operating central and power stations—a subject upon which too much stress cannot be laid. While the question of firemen has been discussed before the National Electric Light Association, and its importance is freely acknowledged by station managers whenever it is brought forward, yet it cannot be said that much progress has been made in carrying out the many suggestions offered. One reason seems to be a disinclination on the part of employers to offer the wages of skilled labor to a class of workmen who have from time immemorial been considered as not differing from day laborers—the reluctance having probably its real cause at the present day in the fear of establishing a precedent that might lead to demands for increase of pay from other classes of employes. Of the different items that go to make up the cost of producing electrical energy, but few in a given case are capable of being materially reduced; the capital charges are fixed, the costs of management, superintendence, and labor are usually kept at a point not admitting of further economy, but the large item of fuel, though its importance may be recognized, is yet the one that in most cases receives the least intelligent attention. It is true that firemen are the subject of much complaint, and it is generally felt that the boiler room is a weak point in the station economy, but it is rare that the remedy, and there is but one, is applied—the payment of the wages that the skill required warrants. That skill and intelligence on the part of the fireman are demanded should not be a matter ofopinion, for it can readily be seen that the conditions predicate them. There are definite conditions for a maximum economy in burning a given fuel, and as these conditions vary with the rate of combustion, an intelligence is required that cannot be expected of the day laborer. Furthermore, the attention necessary to see that the fires are kept in proper condition, the frequency and quickness with which they should be fed, and the care required in properly working them are what one cannot expect from those receiving the usual rate of wages now paid, even if they should possess the necessary intelligence. When it is once generally recognized that firing is a skilled trade, and when firemen are paid as skilled workmen, then we may expect to hear less often of stations using from four to six pounds of coal to develop an indicated horse-power.

ARC LAMP CARBONS.

We have referred several times to the great influence of the quality of arc lamp carbons on the candle power, and in the present issue Prof. Stine confirms our statement that the light given with

different carbons in lamps using the same amount of energy may show a difference as high as 50 per cent. In the article to which we refer stress is laid upon the fact that the electric arc is not the direct source of light, and that the real principle is the same applying in the case of other illuminants, which is that of the action of heat upon a vapor, rendering it luminous. The function of the carbons in acting as electrodes has nothing directly to do with the production of the light, that depending upon the quantity and quality of the luminous vapor which they supply under the action of the intense heat of the arc proper. It would be absurd to judge of the value of a gas without reference to its light-giving qualities, but this is what is too often done in the case of carbons, the question of life being usually the one which determines a selection. As pointed out, the intense brilliancy of the arc renders it difficult for the eye to appreciate readily and directly even great differences in candle power, so that variations which would be at once detected and not endured in the case of other illuminants, do not receive prompt attention when occurring in arc lighting. Perhaps the comparative newness of the light has also something to do with the lack of concern manifested, for the quarrels now so frequently occurring between arc lighting companies and their customers on this score seem to indicate that the public is finally learning to appreciate the difference between a good arc light and a poor one. The qualities necessary for a good carbon follows from the definition given of its true function. It should give off vapor readily, and of a quality to radiate the greatest number of luminous rays, and be of uniform texture. If it does not possess this latter property the arc will be unsatisfactory, even if the carbon is soft and of good material, as conditions will be introduced that will not permit it to burn to the best advantage. To vaporize readily, the carbon must not be hard, and, therefore, its life cannot be as great as that of a hard carbon. The same caution here applies with respect to long life as in the use of incandescent lamps, a long life in the latter case implying a direct loss instead of a saving. As a consequence, an arc carbon recommended to burn an unreasonable number of hours should be avoided, as long life will here, also, through the lesser quantity of light given, more than overcomes the difference in cost. When light becomes to be considered as light and not measured in lamp-hours, and is paid for according to this basis, these considerations will be given their true weight, and poor carbons will be rated at their real value.

THE CLEVELAND CONVENTION.

The Convention of the National Electric Light Association at Cleveland promises to be even more important than that held at Washington last year, though the latter was, in many respects, perhaps the most important in the history of the association. The interim between these meetings has witnessed such an unusual number of events affecting the electrical industry that the older members have doubtless been reminded of the earlier days of the Association, when the interval between meetings often witnessed a revolution in the art or its methods. While the expiration of the incandescent lamp patent and the invalidation of the feeder-and-main patent were most interesting events, the practical effect, however, was comparatively slight and the Convention will have brought before it several matters that promise to affect more largely the interests of its members during the coming year than they have been by the occurrences in the one just closing. The most important of these is the subject of power distri bution by alternating currents, which the rapid perfection of induction motor is quickly bringing to such a point that it can no longer be neglected by the central station manager. Should the claims now being made in regard to the practicability of using these motors for general power distribution on lighting circuits be maintained, and this seems probable, the continuous current will be definitely placed in such a serious state of inferiority as to give real cause of alarm to its adherents, and should tend to make them consider the advisability of taking advantage themselves of the new advance rather than wait for it to be exploited by a rival. Another subject also coming well to the front is that of central station storage which, as far as relates to storage batteries, has already received an impetus from the recent ending of the unfortunate litigation which so long had crippled the industry. The paper on direct connected arc dynamos will doubtless be submitted to a thorough discussion, and unless it is shown that real objections exist against such machines, we may expect as a result their rapid adoption in all large stations, and one of the principal causes thus removed of the remark so frequently heard in regard to the backwardness of arc lighting from a technical standpoint. Another subject of lively interest to be brought before the Convention is the competition of the Welsbach burner, and in this connection we think that stress might be laid by the older members on the fact that the present "scare" is but the recurrence of others that have several times before taken place on the same subject and had in each case but a short existence. The character of the light given, the unsightliness of the mantle, its fragile character and the trouble which its use entails, will probably again have the same result as when on previous occasions it for a time received the favor of the public, and of this fact indications are already to be seen in New York City.

COAL CONSUMPTION IN CENTRAL STATIONS.

The article by Mr. E. A. Merrill, in another column, will be found an important contribution to a subject of vital importance in the design and operation of generating stations, and we know of no other paper on the same subject which has so thoroughly considered all of the factors involved. Much has been written of the influence of the load factor, but usually in general terms or based upon only part of the factors entering in economy of operation. In the tables accompanying the article, however, will be found figures that can be accepted with the assurance that they embody every quantity affecting the result, and represent all the different types and sizes of engines now generally employed in stations. As will be seen, the coal and water consumption are referred to the dynamo and this, as remarked by the author, is the only logical basis of comparison, as will be realized upon consideration of the varying rate of the many losses between the boiler and switchboard. A striking illustration of the influence of the load factor is given by the various curves. In Fig. 5, for example, we find that with the most efficient type of engine and dynamo, and generating a kilowatt-hour on about two and one-quarter pounds of coal at full load, this figure is increased at 10 per cent. to 11 pounds, and even at 30 per cent. is 5 pounds; with the least economical type of machinery, these figures become 34 and 21 pounds respectively. It should be understood that the data from which the curves are constructed are not based upon theoretical deductions, but are taken from good engineering practice, while the machinery is that supplied by good makers, and assumed to be operated under ordinary conditions. Considerable surprise was expressed at some of the data reported at the Washington Convention of the National Electric Light Association by the committee investigating the subject of fuel consumption in central stations, but in the light of the results of Mr. Merrill's study it will be seen that the returns showing even the lowest economy were well within the possible limit. The lesson to be derived from this investigation is the absolute necessity, in the absence of storage, of so proportioning the units of a station as to admit of each unit being worked at as nearly full load as possible. The general remedy, however, seems to be the employment of an auxiliary storage system, particularly where the load varies over wide ranges. It should be borne in mind that such a system, aside from very largely decreasing the consumption, would also entail other advantages and savings, as demonstrated in European practice. In conclusion we desire to call attention to the author's remarks on the necessity, in order to enable reforms to be initiated, of comprehensive and accurate station records, in detail, accompanied in each case, when published, with a description of the station equipment and details of operations; with these data in hand all will agree with the opinion expressed that much of the uncertainty now surrounding the subject of coal consumption will be dissipated. The desirability of referring the consumption to the out-put at the switchboard is also evident, and that method should be more generally followed.

Since the Last National Electric Light Convention.

The Convention of the National Electric Light Association at Cleveland during the present week naturally recalls the several important events affecting the electrical industry that have occurred since the Washington meeting, and which our artist has attempted to pictorially represent. The expiration of the Edison lamp patent last November was the most notable electrical event of the past year, but its effect had previously been largely discounted and the uncertainty in regard to the result of the Bate refrigerating case has probably resulted in restraining the great competition in the incandescent lamp field, which was so confidently looked forward to.

The decision in the feeder-and-main case also served to clear up the atmosphere, and the opinion of the Court had the effect of strengthening the growing tendency of Federal judges to apply a more severe construction as to what constitutes invention—a tendency quite marked in the opinion of Judge Grosscup in the recent arc regulator case. Another principle in patent law of interest to the electrical public generally, and which is also being more literally interpreted, was that involved in the Berliner case, Judge Carpenter basing his decision upon the Supreme Court opinion of last year restricting the practice of issuing two or more patents on substantially the same invention—using the word in its latest legal sense.

The cessation of hostilities among storage battery manufacturer through a combination of their interests was received with a pleasure not usually felt toward similar business arrangements; it was felt that a promising industry had been stunted by the incessant litigation to which it had been subject for years, one effect of which was to discourage the application of the storage battery in this country to many cases in which its value had been strongly demonstrated in Europe.

Perhaps one of the most important advances made for years in connection with arc lighting was the recent direct-coupled arc dynamo installation at Chicago. The use of large arc units, which at the Washington Convention was discussed as an innovation, has, during the year, entirely passed through the transition period and entered into every-day commercial practice.

The Niagara plant, while not yet in operation, has nevertheless passed into such a stage that its success from an engineering standpoint is no longer the matter of conjecture that it was reasonably considered to be at the Washington meeting.

A New Method for Deducing the Expression for Electromagnetic Force.

BY CARY T. HUTCHINSON, PH.D., AND E. R. CARICHOFF, M.A.

The usual method followed in deducing the expression for electromagnetic force, even in the simplest cases, is very abstract and does not leave a satisfactory impression upon the mind.

The following deductions are presented as tending to afford a clearer understanding of the facts involved, while involving none but the simplest notions:

"The magnetic force at a point is the force which unit pole at the point would experience."

"The strength of a magnetic field is measured by the magnetic

FIG. 1.

force at each point, and is represented by the density of the lines of force, one line of force per unit area corresponding to unit magnetic field. At unit distance from unit pole, the force, by definition, is unity; the area of unit sphere is 4π; therefore, from unit pole 4π lines of force radiate, since each unit area must have one line."

"When by any means whatever the number of lines of force passing through a circuit carrying current, C, is changed by N, the total work done by or upon the circuit is equal to CN."

This is Faraday's fundamental experimental result; all that follows is based upon it.

Faraday's law involves a definition of unit current, in order that the work may be numerically equal to 4π times the product of the current by change in flux.

Biot and Savart and Maxwell have shown experimentally that the force due to a current in an unlimited rectilinear conductor on a pole of unit strength at a distance r from the current is $\frac{KC}{r}$, where K is a constant to be determined so that the expression for work done shall be equal numerically to NC.

To determine this constant:

Imagine unit pole at P; let the conductor, AB, revolve uniformly about P, describing a cylinder of radius, r. The con-

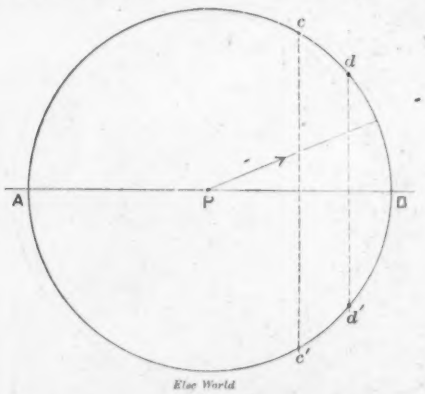


FIG. 2.

ductor cuts the entire 4π lines which radiate from the unit pole; the work done is therefore $4\pi C$. The distance that the conductor moves is $2\pi r$, and the uniform force is $\frac{KC}{r}$.

The work then is:

$$W=\frac{KC}{r}\,2\,\pi\,r=2\pi\,KC.$$

This must equal $4\pi C$, and therefore $K=1/4$. This is the usual electromagnetic definition of current, but obtained in a different way. With this definition of unit current the expression for work becomes numerically equal to NC. Using this we shall deduce the expression for the force in other cases.

I. To find the expression for the force at the centre of a circle of radius, r, due to current, C, flowing around the circumference. Imagine unit pole at the centre, P. Revolve the circular conductor about a diameter, AB, through 180 degrees; then all the 4π lines from the unit pole will be cut, and the total work done will be $4\pi C$.

Each element of the conductor, as cd, contributes a part to the work proportional to its length and to the distance it moves through. The sum of all these products of length and distance, however taken, is equal to the surface of the sphere, or $4\pi r^2$. If then $\mathcal{F}$ be the force due to unit length

$$\mathcal{F}\times 4\pi r^2=4\pi C.$$

$$\mathcal{F}=C/r^2.$$

The force due to the entire circumference is

$$\mathcal{F}'=2\pi r\times\mathcal{F}=2\pi C/r.$$

II. To find the force at a point within an indefinitely long solenoid:

Let there be n turns per centimetre. Assume unit pole at P

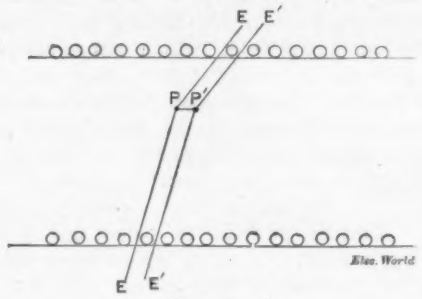


FIG. 3.

to move parallel to the axis to P' where $PP'=(1/n)\,Cm$. Every line of force will cut one spire of the circuit, for any line that was at E moves to E' and $EE'=PP'$.

The entire circuit will then be cut by all 4π lines of force; the work will then be $4\pi C$, and the uniform force between P and P' will be $4\pi C/1/n=4\pi\,n\,C$. This is irrespective of the position of P within the solenoid.

Electrical Energy Obtained Directly from the Cold Combustion of Coal Gas.

BY CARL HERING.

In connection with the recent experiments of Dr. Borchers which have been attracting so much attention, the following simple little experiment made in 1883 by Mr. von Dobrowolsky and myself, at the suggestion of the former, may be of interest as it seems to show conclusively that a cell *can* readily be made in which the cold combustion of coal gas (or at least some constituent part of it) with atmospheric air will take place, yielding its energy in the form of an electric current.

Two carbons, such as used in Leclanché cells, were carefully cleaned and platinized with platinum black; they were then placed in dilute sulphuric acid and kept short-circuited for some time in order to discharge them, should there be anything different in the two causing a difference of potential. One was then placed in a jar containing ordinary illuminating gas from the street mains and the other was held in the air. After a while they were inserted in the dilute sulphuric acid and connected to a crude galvanometer made of a small coil of wire around a pocket compass. The current obtained when started and stopped at proper time intervals caused the needle to spin around on its pivot with considerable speed. It may, therefore, be said that a motor, although only an infinitely small one, was run with the energy thus obtained. No further measurements were made as it was considered to be of no practical interest and as we had no suitable measuring instruments at the time.

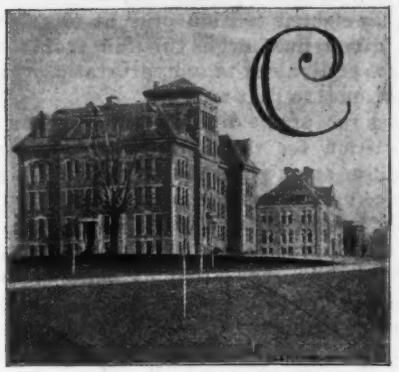
I believe that the problem of the conversion of the energy of coal into electrical energy without the aid of that frightfully wasteful converter, the steam engine and boiler, will be solved first by some of the numerous possible indirect ways. If scientists and inventors would direct their attention to these rather than to the direct methods we would, I think, be relieved much sooner from the necessity of using the wasteful steam engine and boiler, which, although very useful in the absence of something better, must still be regarded as merely a temporary, unsatisfactory makeshift. The efficiency of the engine boiler converter is so very low that it will require but a very poor and inefficient electrical converter to relegate it to the museums.

Two Thirteens a Lucky Combination.

Miss McLaughlin, cashier of THE ELECTRICAL WORLD, completed, on February 13, her thirteenth year's service on the paper. Not only all the money, but all the correspondence has passed through her hands. Probably a million letters have been opened by her during this time.

Manual Training and Technical Education in Cleveland, O.

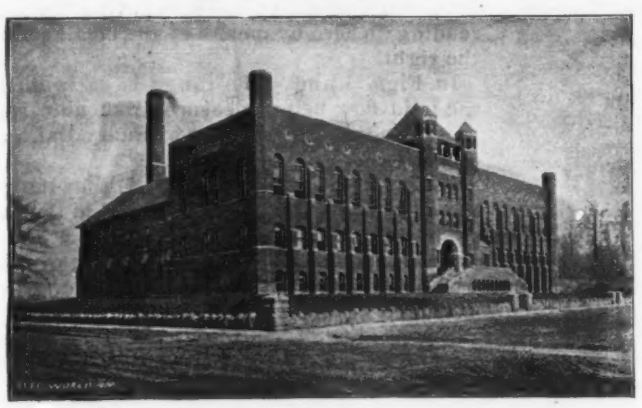
BY E. P. ROBERTS.



CLEVELAND being a city noted for the excellence of its schools and also for its manufactures and its engineering works, it is not surprising that manual training and technical education have been carefully developed there.

The manual training schools connected with the public school system are two in number — the Central Manual Training School and the West Manual Training School. Both of these schools are for high school students, and are under exceptionally competent instructors—Mr. W. C. Skinner and Mr. W. E. Roberts, respectively. Before reaching the manual training schools the students obtain a very considerable training of the eye and hand while passing through the primary and grammar grades, such as clay modeling, work in paper and card board, drawing, knife work in wood, etc. The University School, under Mr. N. M. Anderson, principal, and with Mr. S. P. Rider and W. E. Graves in charge of machine work and carpenter work, respectively, is a high grade school, preparing boys for classical or technical courses in college. Special attention is given to manual training and with marked success.

Adelbert College is a portion of the Western Reserve University. Its most recent building is the physical laboratory, which is in charge of Prof. Whitman, assisted by Mr. W. M. Woodworth. In the design of the building great care was taken in the special adaptation to advanced work in electrical measurements. The two rooms used for electrical work are entirely free from iron in their construction, have a cement floor, solid brick piers, and slate slabs built into the wall to accommodate the most sensitive instruments. A good sized storage battery has a room by itself, and current for charging this is kindly furnished by the street railway company.

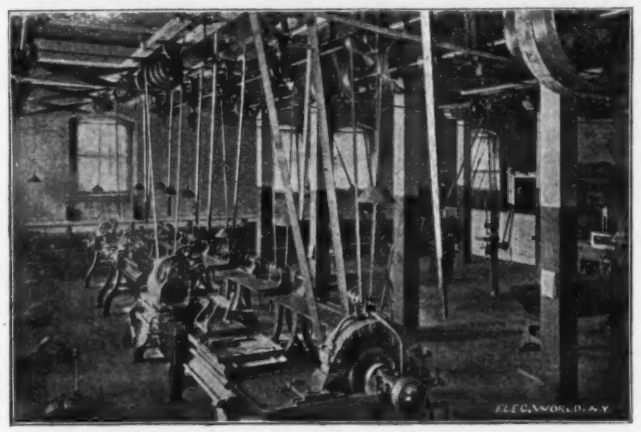


UNIVERSITY SCHOOL.

In the dynamo room is a small Brush arc light machine and a Westinghouse incandescent machine for lighting the building. The latter was designed by the Westinghouse Company for this laboratory, and is provided with collector rings, so that a 110-volt direct current and a two phase alternating current may be obtained from the machine at the same time. A switchboard with the usual station indicators, volt and ammeters, and converters completes the electrical equipment. The department of physics is in charge of Prof. Frank P. Whitman.

The Case School of Applied Science was founded in 1877. During the past few years, and under the leadership of President Cady Staley, it has made most marked progress. It has a well equipped mechanical department under Prof. C. H. Benjamin, and the electrical department under Prof. J. W. Langley is most efficient. Civil engineering, technical chemistry, etc., are all given in the most thorough manner, and under exceptionally competent instructors.

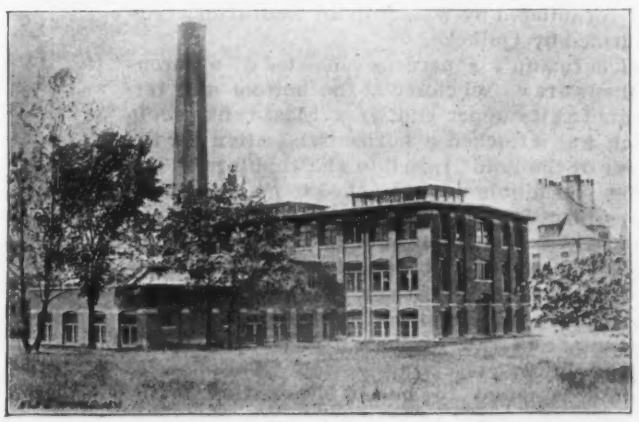
The following information in regard to the course in electrical engineering we extract from the last annual catalogue: The course is intended to fit students for professional work in the various branches of applied electricity. To this end the instruction is both theoretical and practical, and is combined with so much of the courses in mechanical engineering and physics as will form a preparation from which to specialize in the direction of electical work. During the first two years the instruction is nearly identical with that in mechanical engineering. In the third year a thorough course in theoretical electricity is given; this includes lectures and recitations on the principles of the science and its elementary mathematical treatment. A large portion of the afternoon hours is devoted to laboratory or shop work. In the electrical laboratory students make measurements of resistance, potential, and induction by all the recognized standard methods. In the shop they have tests of materials dynamometer and indicator practice with the steam engine, and general shop work. In the fourth year theoretical electricity in its advanced development is taken up. On the practical side students give special attention to methods of testing and measuring the out-put of dynamos and motors; methods of wiring for arc and incandescent circuits and testing for faults in the same; photometry of electric lights and distribution of power for street railroads and other purposes. The principles of dynamo and motor designing receive practical illustration. In addition to this a considerable fraction of the time of the last two years is given to details of construction. This is an important feature of the course; each student personally constructs at least one part of a dynamo or motor on a commercial scale of magnitude. The increasingly important applications of electricity to the treatment of ores and the reduction of metals also receive working illustration in the electrical engineering laboratory.



WORKSHOP, UNIVERSITY SCHOOL.

In addition to the customary outfit of galvanometers, voltmeters and ammeters, the electrical engineering laboratory contains two engines, four dynamos and a 108-cell storage battery.

Frequent visits are made to electrical establishments, and each student before graduating must present a thesis on some topic connected with the commercial applications of electricity.



ENGINEERING LABORATORY, CASE SCHOOL OF SCIENCE.

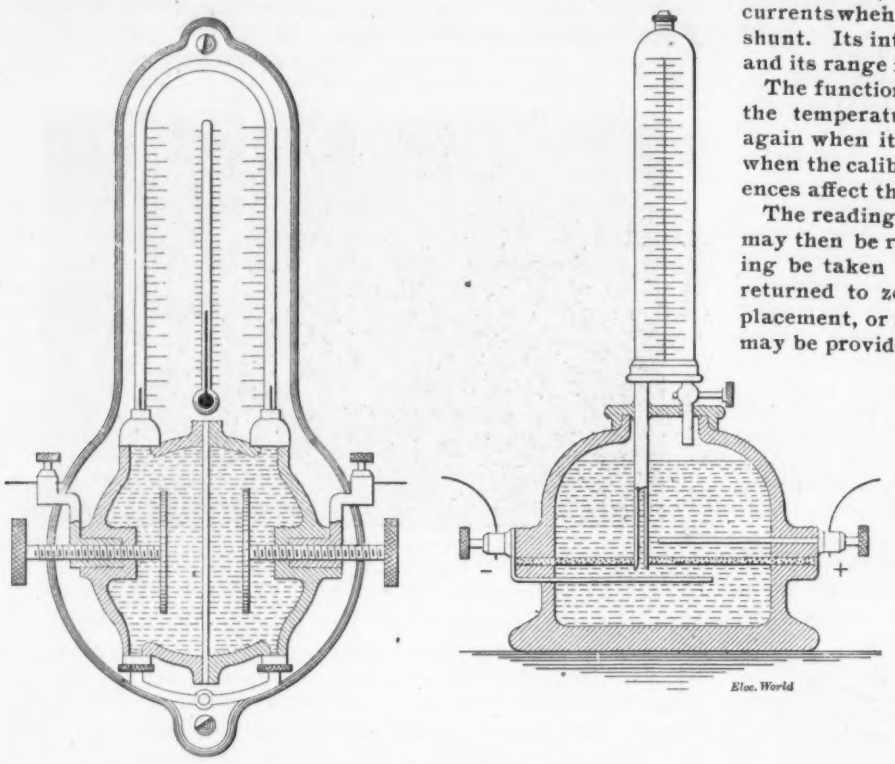
If any of the exhibitors at the National Electric Light Convention have any question as to what to do with their exhibits after the close of the convention, it is believed that Prof. Langley will give them full instructions.

Suggestions for Metering Devices—VII.*

BY S. D. MOTT.

Osmotic Meters.

The curious action of liquids subjected to electrification in the capillaries of porous materials known as electro capillary phenomena is a field for research promising in results, I believe, to the scientific investigator, and one which has so far been comparatively neglected.



FIGS. 1 AND 2.—OSMOTIC METERS.

Under this head is the osmotic flow of fluids from the positive to the negative electrode of a conducting path, which may be observed by the difference of level of fluids capable of mixing through a porous diaphragm separating them, which difference of level is the result of the circulation of electric currents.

This has the sound of a familiar physical principle, and it is up to a certain point where we become involved and environed by physical actions not wholly understood but which are well worthy painstaking research.

This phenomena, first observed by Porrett, was confirmed by Quincke, Crosse, Wiedermann, Miller, and others. The laws of endosmic action were first formulated by Wiedermann and afterwards confirmed by Quincke.

Wiedermann's apparatus consisted of a porous earthenware vessel closed at the bottom and terminated at its upper end by a glass tubulure, to which was attached a horizontal section for the escape of the liquid raised in the tubulure. The battery terminals were attached to platinum electrodes placed respectively inside the porous cell and in a vessel of water outside the porous cell in which the porous cell was placed. On the passage of current from the outside containing cell to the inside of porous cell the liquid rose in the glass tube and ran through a horizontal section thereof into a receiving vessel. The flow of liquid was found to be in proportion to the strength of current and the action otherwise conforming to the following laws:

I. The quantity of fluid which flows out in equal times is directly proportional to the current strength.

II. Under otherwise equal conditions the quantities of fluid flowing out are independent of the magnitude of the conducting porous surface.

III. The height to which a current causes a fluid to rise is directly proportional to the extent of the porous surface.

IV. The force with which an electric tension present on both sides of a section of any given fluid urges the fluid from the positive to the negative side is equivalent to a hydrostatic pressure which is directly proportional to that tension.

Fig. 1 is arranged as a glass receptacle divided into two compartments by a porous partition for the metering of delicate currents when in direct circuit or strong currents when placed in shunt. Its internal resistance may be made very small indeed, and its range is limited to the height of the scale.

The function of the thermometer is for the purpose of taking the temperature reading when the measurement begins and again when it ends, allowing therefor. This is only necessary when the calibre of the tubulure is such that temperature differences affect the height of the fluid medium on the reading scale.

The reading is taken from the ascending column; the current may then be reversed to bring it back to zero and the next reading be taken from the other column, or the instrument may be returned to zero through the medium of the electrodes by displacement, or a communication between the two compartments may be provided as is shown at the bottom of illustration.

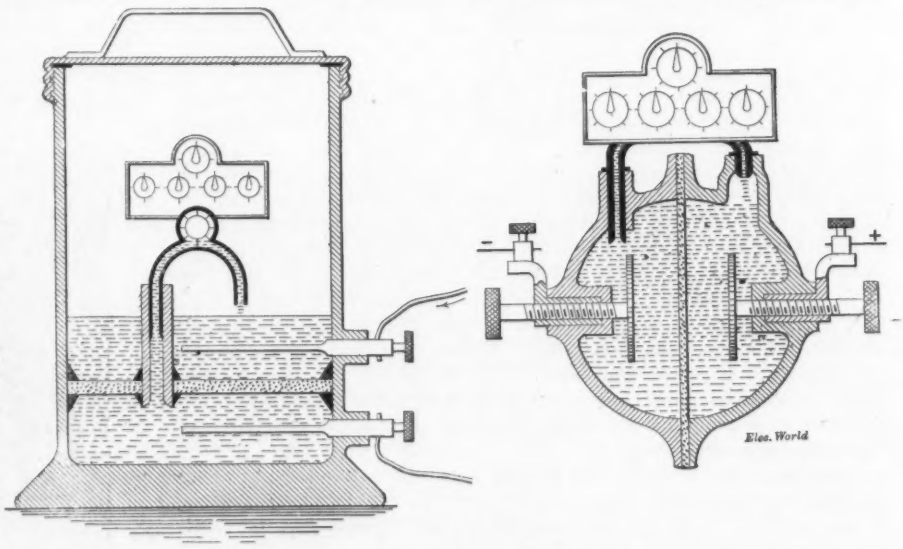
It is believed that such an instrument could be made to meter the most delicate currents; such, for instance, as telephone currents, and for this purpose may be standardized to measure such in arbitrary units or the time use of such instruments and kindred instruments used in commercial life.

Fig. 2 is substantially the same except that the fluid medium is delivered into a larger scaled measuring tube for the purpose of increasing its range of action. In this case the fluid would be scaled down, reducing the meter reading to zero by means of the small cock on the right.

In Figs. 3 and 4 the range is *ad infinitum*, the fluid flow being measured like unto water or gas and registered on an ordinary dial mechanism.

It may be well to state (Fig. 3) that the part which measures the flow may preferably be placed in the down leg of the siphon. The hydrostatic balance of Figs. 3 and 4 is nearly perfect, sufficiently so for all practical purposes. These instruments, made of glass, have the valuable characteristics of cheapness, simplicity, and accuracy.

It is the opinion of several well-qualified experts to whom I have taken occasion to submit the suggestions herewith illustrated that they present a plausible basic principle for the construction of electrical instruments of precision. Some of them are quite positive in their judgment.



FIGS. 3 AND 4.—OSMOTIC METERS.

The first two laws set forth above would seem to indicate plain sailing in making practical applications of them, but the usual "bug" of the genus electrolysis confronts us to be dealt with.

* For parts I., II., III., IV., V. and VI. see THE ELECTRICAL WORLD, of Jan. 14, 1893, page 26; Jan. 28, 1893, page 63; Feb. 11, 1893, page 105; March 4, 1893, page 162; March 25, 1893, page 228; Aug. 19, 1893, page 129.

The first question is can we have a propagation of fluid conforming in its action to the above laws without electrolytic action, *i. e.*, without either the evolution of gas or the carrying of metals, or either one of these actions without the other. Are there combinations of elements which will eliminate these factors or render them negligible?

We are told there would be no metal carried from platinum or iridium electrodes provided a properly selected solution devoid of chlorine were used, and with fluids like mercury gas is not evolved, yet it is subject to electro capillary influences. The electro capillary propagation of mercury has been used for E. M. F. readings, but seems to have been ignored by experimentalists for the metering of currents.

The fused salts of borax conduct electricity and are said to be not subject to chemical action from such use. Could not mercury be used as the fluid conductor, and lead or its equivalent, such as would not be attacked by the mercury, be used for the dividing partition?

If an intervening space between two bodies of mercury formed by two porous diaphragms be filled with nitrate of mercury, would not the desired results be obtained? I have a distinct recollection of having seen these elements used for metering currents by having two receptacles containing mercury connected by a tubulure filled with nitrate of mercury disposed as a balance, the oscillation of which—by the preponderance of weight to one end or the other as the mercury was transferred to the negative end by the current—being registered on an ordinary dial and the current being reversed at the completion of each pendulation in the manner similar to the balance beam electrolytic meter.

Assuming such a combination a practical reality, the arrangement of parts such as is indicated in the drawings, but using two diaphragms instead of one, as described, should make a satisfactory instrument.

Experimentation with animal substances such as albumen, or vegetable products as sugar, might be found promising elements; these play an important part in the economy and sustenance of the human frame and perform their functions by endosmic action, or what is so nearly allied to it. imbibition.

Do porous diaphragms intercept the electrolytic carrying of metals in an otherwise properly arranged bath? It is evident that if a partition, porous or otherwise, were of such a nature as allowed electrolytic action to take place through it, *i. e.*, if such a diaphragm were interposed by immersion between the anode and kathode resulting in separating the bath into two independent receptacles, the mere act of *displacement* of fluid by the building up of a metallic deposit on the kathode would totalize the current passing, which could be read off a scaled tube, as represented, the same action taking place as in the commercial chemical meter, except that no weighing would be needed.

It may be unfortunate that some form of liquid must be a functional part of this apparatus, but the great advantage of simplicity and cheapness is gained, as the instrument may be made wholly of glass, except the binding posts and diaphragm.

Some time since I took occasion to look up the state of the art as related to this type of instrument, but unfortunately have mislaid my notes taken at the time and cannot, therefore, treat the subject as fully as I had intended, but can say that what the records do not contain is much more interesting, I believe, and quite as important possibly as what they do contain.

Possibly some of your readers who have special knowledge of electro capillary or electrolytic actions, derived from practice or experiment, may be inclined to throw fuller light upon this interesting subject.

Electricity and the Alps.

One of the Swiss newspapers, says the London *Electrical Engineer*, makes merry in a good-humored way over the proposal to build a railway up the Jungfrau. "This is no question," it says, "of compressed air. Electricity will afford the means of traction. The tunnels will be lighted by it; there will be stopping places at all the principal glaciers, and two miles up will be seen the notice 'The Eiger Station—ten minutes to wait!' A natural glacier will be provided alongside the railway, and the train then passing around the huge mass of the Eiger will draw up at a plateau that is only clear of snow in summer. Seven and a half miles at £40,000 a mile! That is what this project is to cost. Twenty years ago it would have been considered a chapter out of one of Jules Verne's books. To-day the men of money who were afraid to give half-a-crown for one of Verne's books are willing to advance nearly half a million for the work."

The Influence of the Carbons on the Candle Power of the Arc Light.

WILBUR M. STINE, D SC.

The history of the development of the two existing methods of electric lighting present a marked contrast. In the case of the incandescent lamp, attention and investigation were of necessity directed toward the source of illumination, or the susbtance, which heated to a condition of incandescence, emitted the light. Since common usage adopted the carbon filament it has been diligently studied with reference not only to its working life but more especially to the quality of the light emitted and the best economic conditions under which a filament should be operated. At present the leading consideration in the selection and operation of incandescent lamps is not so much life in hours, but watts absorbed per candle power. In bringing this about an influence has been at work which is not ordinarily considered. The incandescent lamp had to compete directly with both oil and gas flames of approximately similar candle power. The public was, in a sense, accustomed to use the eye as a rough photometer and could form quite accurate estimates of the quality and the quantity of the light emitted by incandescent lamps in comparison with gas and oil flames. With the arc lamp the case has been entirely different. Here the eye is of but slight service in estimating either the quality or the quantity of light emitted.

The arc lamp emits a light which differs materially from all other generally used illuminants. The color of the arc is pale blue or white with a bluish tinge and contains less of the lower or red rays of the spectrum than the oil, gas or incandescent lamp. The light emitted from these sources is strongly yellow in cast. Again, the light of the arc being unusually rich in the upper colors of the spectrum consists of rays of lesser amplitude than other lights, or its penetrating or emissive power is proportionately less. As a consequence, a gas flame or an incandescent lamp viewed from a distance through a fog, looks proportionately brighter in comparison with an arc lamp than when the night is clear. This fact has, doubtless, had some influence in minimizing the brightness of the arc light in the eyes of the public.

Other illuminants possess considerable area of light-emitting surface per candle, but the powerful light of the arc is concentrated into a mere point in comparison. The eye, in short, is too greatly blinded by an arc to be, in any sense, a judge of its brightness. The candle power of the arc, too, so greatly exceeds that of any other illuminant that the public does not generally appreciate the candle power of the arc as a source of illumination. It would seem that these several causes had greatly contributed to the neglect of all considerations of the influence of the carbons burned in an arc lamp upon the quality and quantity of light emitted. Here, it may be stated, lies the contrast in the development of the arc and incandescent systems for lighting.

The arc dynamo has been brought to a high state of efficiency and the lamps for such circuits have received no less attention, so that there now exists the anomalous condition that the perfection of the lamp generally exceeds that of the carbons burned in them. At the outset it would have seemed that the mechanism needed to insure a steady arc under commercial conditions was too complicated to enable it to become successful. Yet patient effort has evolved a number of lamps which leave little to be desired so long as carbons must be burned to produce light. But all the excellence in dynamo and lamps counts for but little when, through ignorance or carelessness, poor carbons are used in the lamps. To bring the incandescent and arc systems into contrast again, the former has been operated with more uniform satisfaction to the consumers than the latter. The reason is not far to seek—every central station manager knows it matters a great deal what incandescent lamp he may select, while few stop to consider the candle power quality of the carbons they purchase. Carbons are too frequently bought on considerations of long life and cheapness, though the same policy would prove ruinous if applied to incandescent lighting. This carelessness seems to be most apparent in the operation of the smaller plants. The extra expense which is incurred by small towns in lighting its streets with arc lamps is a serious consideration. The town council usually debates the question well before making the choice. They are led to believe the new illuminant will make the streets well lighted, and expectation reaches a high point. After the lights have been in operation for a time it is often realized that the lamps are not yielding their expected light. Comparisons are made with other towns similarly lighted, with the conclusion that their own

plant is not coming up to contract. But the blame is not placed where it belongs, it usually falls on the dynamo and lamps used. If the system selected be a standard one this blame is rarely merited. It is the common experience of those who have given the matter attention that a particular system has often to meet an unwarranted prejudice. The blame in such cases is to be attached to the manager of the plant, who through false ideas of economy is using a poor grade of carbons. Yet it does not always rest on the manager, for experiments made by the writer have shown that the makers of an arc lighting system, who, to control the whole trade, undertake to make their own carbons do not always furnish these of the requisite quality. The dissatisfaction of town councils can usually be overcome by the intelligent and judicious selection of the carbons used for the lamps.

When studying the physics of the arc with reference to the present subject care must be exercised to distinguish between the simple electric arc and an arc light to be used for purposes of illumination. An electrical arc is due primarily to the interruption of the circuit by an air-gap. With the potential ordinarily employed for this class of lighting the distance over which a spark will pass in air is a very small one indeed. An arc requires to be established by bringing the two points of the circuit in contact and then separating them. The spark no longer passes in *air*, but through the atmoshpere formed by the vaporized ends of the circuit. The electric arc is in most cases but feebly luminous. When a fuse blows or a switch is opened with a heavy current a powerful arc is established, but one of low candle-power.

To employ an arc for lighting purposes presents a problem similar to that met with in the use of flames in general for illumination. A substance must be vaporized in the arc which, at its high temperature, will become intensely luminous, or spend its heat energy in emitting rays which are distributed as far as possible throughout the luminous spectrum. This, in short, is the statement of the problem with which we are dealing. Electrical arcs were things of frequent occurrence and common observation before the time of Davy's experiment. But this classical experiment consisted not in the establishment of an electrical arc but in filling it with a highly luminous vapor. In the year 1800 Sir Humphrey Davy interrupted a heavy battery current passing between two pieces of wood charcoal by separating the carbons, and witnessed the first carbon arc light, an arc emitting a large volume of intensely white light.

There are many points in the physics of the carbon arc light which are by no means definitely settled, yet those influencing its candle-power are pretty thoroughly established. The end of the positive carbon becomes so highly heated that it melts and boils off in vapor. Whether this vapor is carried over to the negative carbon by the action of the current is of but slight consequence. We know that by some means it becomes rather uniformly diffused throughout the arc; some of it burns away in contact with the oxygen of the surrounding air, while a portion is deposited mechanically on the cooler negative carbon. It is this carbon vapor upon which the candle-power of the arc depends. In this function it differs in no respect from the luminous carbon of the ordinary gas or oil flame. The attempts to render gas flames richer in candle-power have an equal bearing on the candle-power of the arc lamp. A high candle-power gas flame is one rich in carbon vapor, and the attempts to introduce solid and liquid hydrocarbons in the gas flame have had their counterparts in similar trials with the electric arc. So far, such attempts to introduce hydrocarbons in the arc by soaking the carbons in them or by injection into the arc through a tube have not proven sufficiently successful to warrant their commercial application, yet they point out a correct principle. The lesson of such facts is that the candle-power of the arc depends upon the amount of the carbon vapor held in it. The mere passage of carbon between the poles of the arc does not insure its operation in increasing its candle-power. The carbon in transit must be in a free molecular or gaseous condition. If it be in little granules, even should they be highly heated, they can emit light only from their surface. The result is that a large amount of carbon passes through the arc without materially increasing its candle-power. Too much stress cannot be laid upon this latter consideration. To the manufacturer and user of carbons as well, it will indicate one of the leading sources of failure of carbons to produce the requisite candle-power. To one versed in these matters, the ordinary arc light is a disappointment and source of vexation. It is usually too blue. It produces a shadow area which often exceeds the luminous. The arc burns on one side of the carbon most of the time, lighting only a portion of the area it should cover. It travels around the carbons with an uncertainty of disposition annoying to those dependent upon it for light. Occasionally the arc is properly centred and meeting with suitable carbon comes up to its required candle-power only to resume a new cycle of vexatious actions. At other times the carbons rapidly vibrate back and forth and the whole lamp seems to whip and pound before it again settles down to steady action. In view of such facts it is little to be wondered at that the arc lamp as ordinarily operated is perhaps the most unsatisfactory means of illumination in use. The globe of such a lamp furnishes an explanation for its erratic behavior. The cup of the lamp is nightly filled with a mass of carbon chunks and granules. But does it ever occur to the manager that this carbon refuse represents a waste of the carbons placed in the lamps? With carbons of the proper quality there would be little, if any, waste, to remove from the globes. The percentage of carbon lost is, however, the least consideration. These granules are evidence of irregularity in the burning of the lamp with consequent diminution of the candle-power.

In this connection may be mentioned another defect often shown by carbons—it is the slight explosions and sudden flaming that accompanies their burning, occurrences which also have their effect in fluctuations of candle-power.

Waiving the question as to the superiority of foreign or American carbons, it will suffice to point out the characteristics of a good carbon. In the first place, a carbon should be uniform in texture to produce steadiness of the arc. The cheaper grades of solid carbons used for outdoor lighting show variations in volatilizing power not only on points on the surface, but throughout the interior mass of the carbon. Of two points on the positive carbon, one hard and the other softer, and equidistant from the negative, the arc will spring mainly from the softer, because it yields more carbon vapor and offers less resistance; such a varying carbon will produce a vacillating arc whose average candle-power is considerably less than if it were stationary, since each change of arc position implies the heating of a cooler mass to the temperature of volatilization. A shifting arc, too, by rapid and unequal expansion will break off large granules from the carbons. Irregularities in shape, even with carbons of the proper quality may produce these same effects. To insure uniformity of texture, carbons must be thoroughly burned throughout, not merely hardened on the outside layer, otherwise gasing carbons will result. There is room here for great improvement in manufacture. Flaring of the arc is too common and should be absent when perfect carbons are used. So far as processes of manufacture can be learned, too much stress is placed on merely high temperatures for baking the carbons. This will either produce a long-lived, low candle-power carbon, or one lacking in uniformity of texture, depending upon how long the carbons have been heated at the highest temperature. Experiments seem to indicate that the best carbons, those of uniform texture, moderate life and high candle-power, are obtained when the kilns are not heated to such a high temperature, but the highest temperature of baking is continued for a longer time than is usual in this country, thus producing a soft carbon and one from which all gasing elements have been removed.

The quality of a carbon can be determined in another way than by burning it. It is a tedious matter to follow the consumption of carbon in an arc lamp by volt and ammeter readings and photometric measurements. The writer has obtained a fairly accurate knowledge of the light-producing qualities of carbons by an electrolytic method. Two carbons are used as electrodes in a 25 per cent. solution of KOH or NaOH. If the cementing substance has not been thoroughly burned out from the carbons, it will diffuse in a short time through the liquid. The positive carbon should be examined from time to time. The action of the liberated oxygen is to consume the positive carbon, and if any variation in hardness is present it will be shown in elevations from which the softer carbon has been eaten away. As the outer layers disappear the rapidity of removal of the inner layers will furnish an indication of the character of the centre of the carbon. A current of two or three amperes will prove sufficient for the test.

Manufacturers have so far paid too little attention to the fusibility of the crude carbon which they employ. It has been a current belief that fineness of grain of the material before moulding was the leading consideration. But uniformity of grain, rather than fineness should be sought. A carbon which volatilizes readily will yield good results within certain limits independent of the grain, provided this be uniform. The candle-power of a carbon is not determined by the fineness of the carbon flour from which it has been moulded,

Bearing in mind that the finished carbon should have all the cementing substance thoroughly carbonized, the carbon must remain sufficiently soft to properly volatilize in the heat of the arc. Another fact is that the nature of the crude material influences this condition as well as the processes of manufacture.

It has already been pointed out that the candle-power of an arc lamp depends on the amount of carbon vapor which it contains. Two carbons of uniform texture but unequal hardness may show, when burned in the same lamp, and at the same watts, as great a difference in candle-power as 50 per cent. The condition of the same watts is stated, for in a given carbon the candle-power varies almost directly as the watts. This has been fully shown by a number of reported tests in Europe, and some recently published by the writer. My experience has demonstrated that the carbons of the same grade, obtained from a reliable maker, are practically uniform in candle-power. When the similar grades of carbons by different manufacturers are compared a wide discrepancy is found in the candle power yielded, and this, too, with nearly the same length of life of the carbons. Manufacturers can then produce a fairly uniform product, but, as a rule, few seem able to obtain the maximum candle-power. When selecting carbons the manufacturer as well as the grade should be considered.

If a good grade of carbons be purchased there are still two considerations influencing the choice of their quality. A carbon may be purchased for high candle-power or for long life. In the same grade of carbons made by a given manufacturer these two conditions are directly opposed. We will suppose the carbons to be of proper quality so as not to waste away mechanically, then the softer the carbon the higher the candle-power per watt obtained, but the shorter the life. These two properties follow very closely a reciprocal relation. The softer carbon will volatilize readily and maintain the arc rich in carbon vapor, but will only burn, say 10 hours. Another carbon will burn 14 or 15 hours, but will yield a bluish light, be less emissive, and of much lower candle-power. In the economics of central station management the use of a carbon purchased simply because it is long-lived is a piece of extravagance. No matter how excellent the generating plant, the line and lamps may be, the long-lived carbon with its blue light and low candle-power renders the whole system inefficient. Since it has repeatedly been shown that the quality of the carbon may influence the total candle-power output of a plant by as much as 50 per cent., it needs no further calculation to show that over 30 per cent. of the total cost of maintenance of the plant is simply thrown away if bad carbons be used. Looked at in the proper light, the added cost of suitable carbons, not too hard, nor too long-lived, and the added expense of trimming is but slight in comparison with a possible total waste of 30 per cent. in maintenance. The frequent use of poor carbons can only be excused through the ignorance or false ideas of economy of the station manager. A grade of carbon is represented to them as cheap and long-lived, and is accordingly purchased. To such people carbons are simply carbons. They seem to think the light is yielded by the electrical current, and anything which will maintain the arc will produce the proper light. They entirely ignore the fact that the current is really secondary and has but little to do with the candle-power of the arc in itself, forgetful that the light is due to the incandescent carbon vapor which it holds.

In many respects all this applies to incandescent arc lighting as well as series, only in series lighting the faults may be more aggravated, since a bad carbon will burn more continuously in a series than a multiple lamp. Incandescent arc lamps are now excellent and reliable if the proper quality of carbons be used in them. Faults and variable carbons have given more difficulty to lamp designers than any other cause. Any ordinary length of arc will produce hissing if the current be strong enough. A lamp adjusted to a given grade of carbon will often hiss when another is used in it. The electric arc has also been shown to have a certain critical point with relation to length of arc and current. Near this critical point the arc will be extremely sensitive and unsteady. Unless the adjustment of the lamp be changed as often as the quality of the carbons it will prove unsatisfactory.

The cored carbon is necessary to such a lamp because the proper softness is not yet obtainable in solid carbons. The lines along which solid or cored carbons should be selected have been pointed out above. In passing, it may be said that the incandescent arc lamp has been largely instrumental in directing attention to the influence of the carbons on the regulation and candle-power of the arc.

If these matters are clearly understood by the central station manager how will he be able to apply them when purchasing carbons? The test by electrolysis is not only easily made but quite conclusive in its indications if supplemented with careful observations of the behavior of the carbons in the lamps. The quality of the light should also be considered; if bluish, the carbons should be rejected in favor of those burning with a white light. Current and potenital readings on a lamp should be taken and the results plotted in the usual way. The contour of the curve will be a great aid to the decision. If possible, these tests should be supplemented by photometric readings. These may be so readily made that they should present no serious difficulty. As the tests are comparative, the light-value of the standard is not of such moment. A home-made Bunson photometer and a standard candle or a standardized incandescent lamp will be all-sufficient. These measurements of different carbons should be made with the same lamp at the same angle and at equal watts, or several readings on one carbon be made and reduced to standard watts as already alluded to. Such an examination will bring out the quality, life and candle-power of the carbons compared.

A New System of Electric Lighting.

The Moore Electrical Company on Tuesday evening, Feb. 12, gave an exhibition at its laboratory, Harrison, N. J., of a new system of producing the electric light, the invention of Mr. D. McFarlan Moore. Among those present at the invitation of Mr. E. J. Wessels, the vice-president of the company, were representatives of the electrical press, Prof. W. A. Anthony, and several other gentlemen interested in electrical science.

Mr. D. McFarlan Moore before exhibiting the new light gave a lecture in which the principles involved were explained and the great modifications pointed out which its application would introduce into interior illumination. Mr. Moore then showed numerous forms of lamps embodying the invention and operated from conductors leading from a distant part of the laboratory where the generating apparatus was installed. Near the close of the lecture some of the lamps were also lighted from a Grenet and from a small dry battery.

The experiments were followed with much interest by the audience, who were particularly impressed by the great variety of effects produced by Mr. Moore in lamps of different construction. While the invention has not yet assumed a practical shape, yet, in the short time of three months during which it has been in process of development, much has been done, and it is thought that by the time patents now pending are issued the invention will have been advanced to the commercial stage. Owing to patents not yet issued the Moore Electrical Company cannot at present divulge any of the details of Mr. Moore's work, the exhibition of Tuesday having been a confidential one.

Another invention of Mr. Moore's that is in a more advanced state is a method of controlling the candle power of incandescent lamps, and equally applicable to continuous and alternating circuits. The attachment for this purpose is simple and inexpensive, and the lamp socket containing it does not differ in external appearance from the usual form. It was shown that by means of this very simple device the light of a lamp on an ordinary continuous current circuit can be varied through its entire range of candle power; in one form exhibited, by turning the usual key a quarter turn beyond its usual "on" position, the candle power is reduced by an amount determined by the adjustment when installed. The same socket may also be adjusted, so that a lamp of given voltage can be used at will on circuits of any voltage.

At the close of the exhibition Mr. Moore was warmly congratulated by his auditors, who were much interested not only in the beauty and variety of effects produced, but also in the character of the novel principle to which they are due; much credit was also accorded to the inventor upon the great amount of experimental work he had accomplished in the short space of three months.

Popular Science.

An electrician in an article in the columns of the Washington *Post*, describing the advances of electrical science, informs the public that "some cities even now have entirely adopted the trolley system, *i. e.*, overhead electric wires by means of which the cars run." He further enlightens them with the intelligence that "by the vibration of tremors of sound in a peculiar instrument attached to a sounding box and electric wires or current, one can actually converse with another person miles and miles away," and in a burst of enthusiasm asks "where would our telephone, telegraph and cable be were it not for electricity?"

The Electrical Transformer.

BY CARYL D. HASKINS.

THROUGH considerations of economy, high pressures must be employed where electricity is to be distributed over a large territory with its lighting centres widely scattered, as is the case in most rural or suburban districts. With this as with water power, or, in fact, almost any known means of power transmission, the greater the pressure used the less the volume needed to transfer a given amount of energy from one point to another. With this reduction in volume, a reduction in the size of the conductor naturally follows, whether it be pipe or wire.

The economy resulting from the use of high electrical pressures through a scattered territory is therefore obvious. It amounts practically to the difference between a comparatively large or a comparatively small investment in copper wire, or, to put it yet more plainly, the use of say, 22 pounds of wire where 360 odd might have been required.

Unfortunately, however, these high pressures cannot under the ordinary arrangement be directly applied to incandescent lamps,

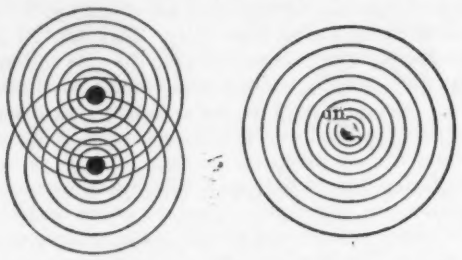


FIG. 1.—LINES OF FORCE ABOUT A CONDUCTOR CARRYING A CURRENT.

since the making of these for pressures greatly exceeding, say 100 volts, is attended with grave difficulties, while the high pressures already referred to frequently amount to 1,000 or 2,000 volts, or more.

It is obviously necessary, therefore, if these high pressures are to be used, that some intermediate piece of apparatus be placed between the lamps and the wires carrying current at high pressure, which shall reduce it to the relatively low pressure needed at the lamps, without serious loss of energy.

This intermediate piece of apparatus is called a *transformer*, or less commonly a *converter*.

The principle of the transformer is based on the law of electrical induction.

When an electric current springs into existence it induces other currents in surrounding conductive masses, and when it ceases to flow it again induces a flow of current in neighboring conductors.

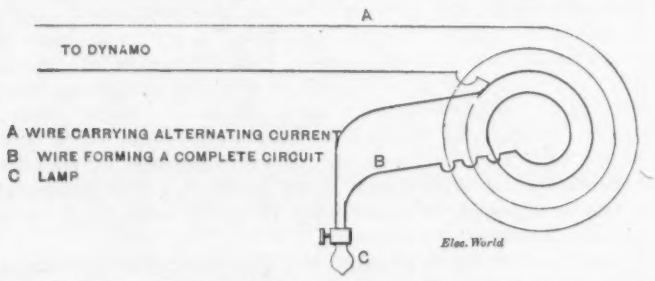


FIG. 2.—SHOWING PRINCIPLE OF TRANSFORMER.

While flowing in uniform quantity, however, it has no inductive effect. This action can be most clearly explained by dealing with the matter from a purely theoretic standpoint.

It is assumed that all active electrical conductors are surrounded by a field of magnetic force, as shown in the second cut of Fig. 1. The black centre here represents a section through a wire forming part of a complete circuit carrying an alternating current. The concentric rings surrounding the wire indicate the imaginary lines of force, little ripples of *energy*, extending equally in all directions, and becoming less and less intense as they become more remote from their source. There is a certain graphic analogy between these lines of force and the ripples that follow the throwing of a stone into still water. The theory on which inductive law is based is: That when a conductor cuts through "lines of force," or vice versa, when "lines of force" cut through a conductor, a current is set up in that conductor provided it be part of a complete circuit.

Turning to the first cut of Fig. 1, suppose that a current springs into existence in the upper conductor; lines of force are immediately projected from it, and these cut through the second conductor, causing therein a momentary flow of current. On the cessation of flow in the upper wire its lines of force immediately contract upon it, again cutting through the lower wire in so doing, and again causing current to flow in the secondary.

This is the action which goes on constantly and with enormous rapidity between the windings of the transformer.

From this it will be seen that a transformer cannot be used on circuits whose current flows constantly in one direction; and for this reason high pressure distribution is ordinarily accomplished by means of the "alternating system," the current in this system changing its direction of flow many times each second.

We see, therefore, that by reason of the law of induction a wire carrying an alternating current and stretched or wound close to another wire forming a complete circuit (through lamps or otherwise), will induce a flow of current in this second wire, commonly

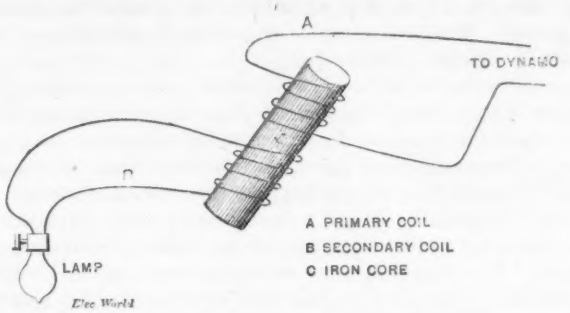


FIG. 3.—OPEN MAGNETIC CIRCUIT TRANSFORMER, IN DIAGRAM

called the "secondary" (see Fig. 2). That is, the first wire, or "primary" will transfer a greater or less part of its energy to the "secondary," more or less power being, of course, lost in the process.

The immediate presence of iron greatly aids this inductive transfer of energy, since average iron, roughly speaking, is some 700 times better as a medium for such transfer than any other known substance, by reason of its magnetic character. Iron is, therefore, practically indispensable in transformer construction, and forms one of the three elements which together make what is, perhaps, the very simplest piece of electrical apparatus at present manufactured.

These "elements" are the "primary coil," the "secondary coil" and the "core," which is, of course, the iron.

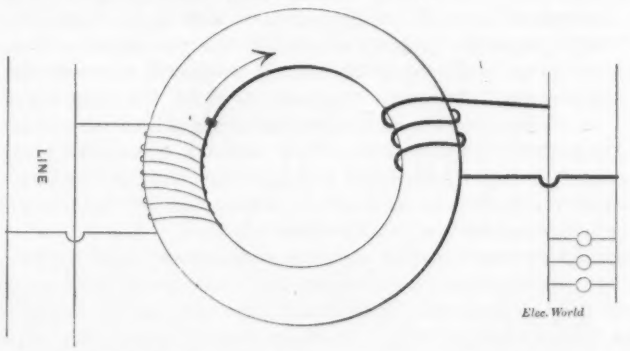


FIG. 4.—CLOSED MAGNETIC CIRCUIT TRANSFORMER, IN DIAGRAM.

A very crude transformer might indeed be made of but three pieces of metal—two lengths of insulated wire and an iron rod, as shown in Fig. 3. Such a transformer would, however, be extremely crude, and a large portion of its energy would be wasted in the form of heat.

To transform electrical energy from a distribution pressure of 1,000 volts to a lamp pressure of 100, for example, almost exactly 10 times as many turns of primary wire would be placed about the iron core as there would be turns of secondary. In fact, to state it roughly, we might say—As Number active turns primary: Number active turns secondary:: Pressure of primary: Pressure of secondary.

The two coils would, however, weigh about the same; for, if the primary coil with a pressure of 1,000 volts were carrying one ampere then the secondary coil would be carrying at a pressure of 100 volts (1-10 the primary pressure) almost 10 times the *volume* of current

of the primary, or 10 amperes. (The discrepancy representing the amount lost in transfer.) The *pressure* multiplied by the *volume* of current equals the *power;* therefore, it will readily be seen that 1 ampere × 1,000 volts is really the same thing, so far as power is concerned, as 10 amperes × 100 volts.

The number of turns of primary and secondary wire, and the amount of iron in a transformer depends mainly upon:

1. The amount of energy to be transformed.
2. The relative voltage of the primary and secondary.
3. The frequency of alternations; that is, frequency with which the flow of current changes its direction.
4. The quality and arrangement of the iron and wire.

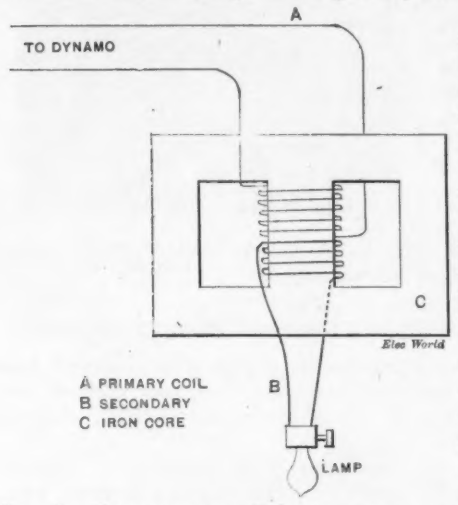


FIG. 5.—COMMERCIAL TRANSFORMER, IN DIAGRAM.

To give the best results the iron core should not be in the shape of a bar, as shown in Fig. 3, but should have its two ends joined together in some way, as, for instance, in the shape of a ring, as shown in Fig. 4, or as in Fig. 5, which is, perhaps, the commonest form of core.

Neither should the iron be in a solid piece; if it were so constructed it would be highly inefficient and cause a serious amount of heat waste, for reasons to be presently explained. It should be built up of thin layers of very soft malleable sheet iron or "low steel," each sheet being insulated from its neighbor by a piece of tissue paper or other non-conductive material, the whole core when built up looking about as shown in Fig. 6.

It is of importance, of course, that all of the wire be as near to the iron as possible, since the iron is the medium through which the transfer of energy is accomplished. In practice, therefore, the holes through the core, as shown in Fig. 6, are completely filled with the two coils (see Fig. 7), which are wound up and wrapped with tape before being placed in position, the entire transformer when ready for casing looking about as shown in Fig. 8.

One of the most important considerations in the construction of a transformer, or, in fact, of any piece of electrical apparatus which is to be used upon high pressure, is the question of insulation. It is vitally important that all three portions of a transformer should

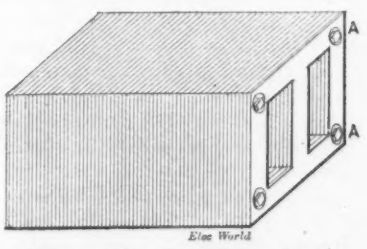


FIG. 6.—TRANSFORMER CORE.

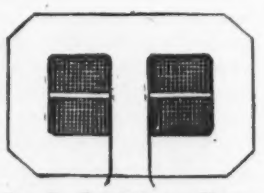


FIG. 7.—SECTIONAL VIEW OF TRANSFORMER.

be absolutely isolated electrically each from the other, and it is the common practice to make the resistance of the insulation sufficiently high to withstand at least *twice* the pressure to which it is expected the transformer will be exposed.

Some manufacturers carry this safeguard yet further and insert insulation sufficient to withstand a pressure three, four, or even five times greater than that on which the apparatus is to operate. The process of manufacture of a transformer is peculiarly simple.

The sheet iron for the core, which is selected with great care and only after elaborate tests to determine its magnetic qualities, is passed, one sheet at a time, into a power punch which cuts out the plates of the size and shape required. By referring once more to Figs. 6 and 8, it will be seen that if the core plates were cut in one piece without a break it would be very difficult, if not impossible, to put the coils and core together, as it would be almost beyond human ingenuity to wind the coils into the core and quite impossible to properly insulate them.

The plates are usually cut in two or more pieces so that the coils can be inserted without inconvenience. There are two general methods of joining the two sections of the core. One is to punch the two halves of the core in separate pieces, as is shown, for instance, in Fig. 9.

The other differs from this method in that the punchings are so proportioned as to overlap one another at their junction, making the magnetic joint in the iron dependent on the lapping contact of plate to plate rather than upon the butt contact as in the first method. When this class of punching is used the core cannot, of course, be built up in two solid pieces before the insertion of the coils. The plates are instead built up around the coils, being laid in alternately and their ends lapped, first right and then left.

There is a third method of building up transformer cores which provides for punchings in but one piece, but of a discontinuous shape. Such a punching is shown in Fig. 10. In building up the core around the coils with this class of punching, the central flap is bent back a sufficient distance to permit it to spring into position in the coils; or the side flaps may be bent back, a similar result following in either case.

FIG. 8.—TRANSFORMER CORE WITH COILS.

The method used in building up a core out of plates of this type is clearly shown in Fig. 11. It will be noted that the break in the plates is placed alternately to right and left, thus reducing to a minimum the magnetic resistance at the point of juncture. The magnetic "resistance" of a piece of iron is dependent quite largely upon its continuity, and all manufacturers endeavor to so build their cores as to make the magnetic junction in their plates as solid and perfect a contact as mechanical necessities will permit. Whether the core be built up in two solid pieces or be of the overlapping type, or of the single punching type, each plate must be insulated from its neighbor, either by a layer of tissue paper—the oxydizing of the

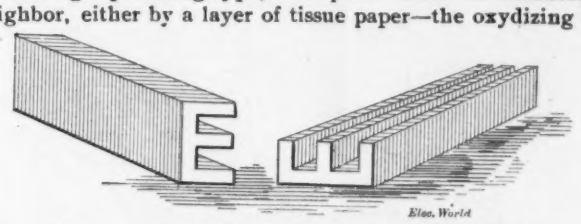


FIG. 9.—ONE FORM OF TRANSFORMER CORE.

plates' surfaces—or some other similar means. This is to prevent the generation of eddy or foucault currents in the core, which, were the plates uninsulated one from another, would cause a serious loss of energy.

We may now consider briefly the various causes of loss which together go to make up the discrepancy between the energy put into the primary and the energy taken from the secondary of a transformer at various loads. The energy passing through the primary coil might, for example, be divided up into various unequal parts, each part performing a different function and expending its energy in a different manner. A certain portion of the energy of the primary is expended in keeping the iron of the transformer magnetized. A certain portion of the energy is wasted in heating the wire of the primary coil by passing through it, a certain portion is wasted in hysteresis, and a certain portion in the generation of foucault currents. By far the greater portion of the energy is, however, transferred to the secondary coil to do useful work. So small in fact is the sum of the waste factors that in a modern high grade transformer of average size, operating upon full load, but 4 or 5 per cent. of the total energy put into the transformer goes to waste, the remaining 95 per cent. being transferred to the secondary as useful current.

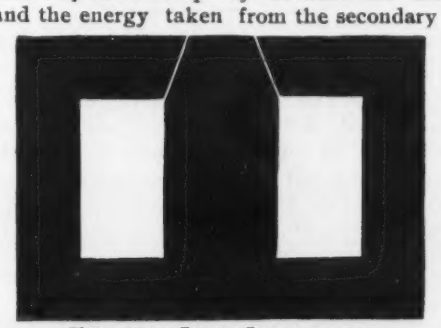


FIG. 10.—CORE STAMPING.

The loss in a transformer, due to waste energy expended in heating the primary, is, of course, due to and dependent on the ohmic resistance of the primary coil, and, of course, a certain amount of energy is lost in the secondary coil in a similar manner.

The energy wasted in foucault or eddy currents is that energy which is expended in inducing in the iron core (and sometimes in the winding themselves if they be of heavy wire) minute waves or eddies of current circulating in the substance of the iron. It is to prevent such waste that the cores of all commercial transformers are laminated.

The eddy currents in a transformer of ordinary shape tend to take somewhat the course indicated by the arrows, as shown in Fig. 12. It will readily be seen that the insulation of the plates one from another almost absolutely prevents the passage of these currents, since they are necessarily of excessively low potential. Where the insulation of the plates of a transformer is properly accomplished, eddy currents in the core are almost eliminated, and the energy wasted by this particular factor is reduced to a figure so small as to be almost negligible.

The loss by hysteresis is perhaps the most difficult to correct and to determine with which the transformer manufacturer has to deal. It represents that energy which is expended in constantly reversing the direction of magnetization within the core. Probably the most graphic method of explaining the hysteresis loss in a transformer is based on the theory of molecular friction. It is assumed that all iron is made up of an infinite number of separate molecules, each molecule having a given magnetic polarity. When a piece of iron is magnetized these molecules are shifted in position, arranging themselves with their poles pointing systematically in one direction.

Let us for a moment assume that these molecules, instead of being so infinitely small and close together as to be beyond the

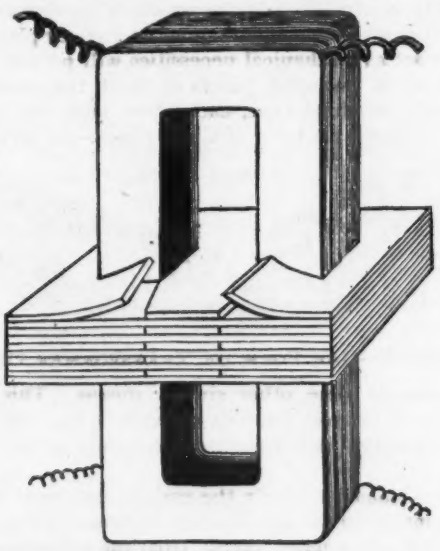


Fig. 11.—Building Up Transformer Core.

detection of the most powerful lens, are of relatively large size, and but loosely associated, as would be the case, for instance, with a mass of iron chips. In Fig. 13 is shown a portion of an iron bar supposed to be constituted of large and loosely associated particles of iron. On the passage of current through the winding around this bar these particles of iron will naturally arrange themselves with a systematic and uniform direction of polarity. On the reversal of the direction of current flow in the coil surrounding the bar, each of these molecules must turn half round to accomplish a reversal of polarity. In doing so it is obvious that a certain amount of friction must result by the rubbing of the particles one against another, and if this reversal were to take place many times each second, as, indeed, in the case in a transformer, the constant friction must of necessity result in heat. This is the theory generally accepted as accounting for the loss by hysteresis.

Both the hysteresis and foucault current losses express themselves in heat, and are generally considered together, the energy wasted by these two losses being determined by the amount of heat generated in the core apart from that resulting from radiation from the windings.

The separation and the determination of the value of the hysteresis loss, and the foucault current loss, individually, is seldom attempted, and is difficult of accomplishment, almost to the verge of impossibility.

In considering the merits of a transformer there are five factors, each of which is of importance and worthy of investigation.

The first and probably the most important consideration is safety to life and property. Too much stress cannot be laid upon the high quality of the insulation separating the primary coil from the core and from the secondary winding. Any connection between the primary and secondary coil necessarily menaces human life, as does also the grounding of the primary coil upon the core. It is vitally important also that a transformer shall not overheat even at full

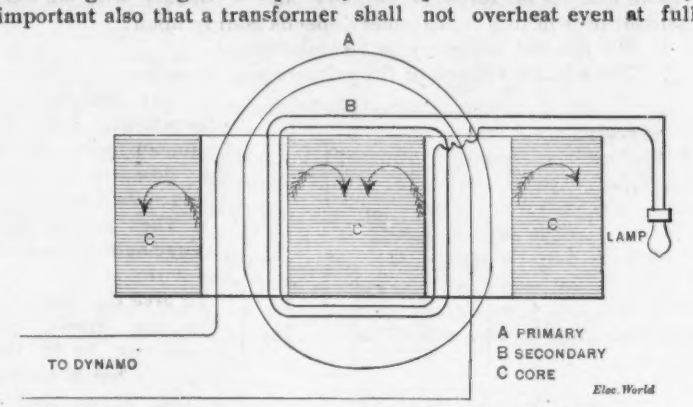


Fig. 12.—Section of Core Showing Eddy Currents.

load. The overheating of a transformer indicates an excessive waste of energy (due to core losses and the like), increases the fire risk, rapidly impairs the insulation, and is detrimental to the good operation of the transformer in every way.

The consideration of next importance is the question of efficiency. It is scarcely necessary to point out that that transformer which shows the least loss of energy between the primary and secondary terminals is the best transformer to use, provided such efficiency is not accomplished at the sacrifice of other important considerations. Over anxiety for high efficiency has, however, in some cases caused the neglect of the third consideration, which is that of regulation.

A transformer of perfect regulation would show absolutely no variation of secondary potential between the points of no load and full load. Absolutely perfect regulation is, however, an impossibility in the commercial transformer, since it would involve the sacrifice of efficiency and other important virtues which are indispensable. The transformer manufacturer endeavors, therefore, to find the most useful intermediate point between extremely high efficiency and extremely close regulation. Regulation which secures a variation of potential on the secondary circuit not exceeding 2½ to 3 per cent. between no load and full load is generally accepted as the most satisfactory.

The other two considerations which go to make up the general merit of a transformer are respectively, durability and convenience in installation and maintenance.

The question of durability is dependent, first, upon good mechanical construction and quality of material, and second, upon the cool running of the transformer.

That transformer which is best protected from storm and rain, and which is manufactured from the highest grades of materials, properly combined, is, generally speaking, the most durable, provided it does not overheat, and by so doing rapidly deteriorate the insulation, for it is the strength and permanence of the insulation on which durability is chiefly dependent.

The question of convenience for installation is one which the eye quickly determines. The presence of convenient connection blocks with a minimum number of screws so placed as to be most speedily

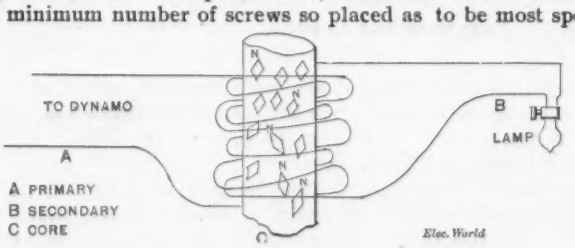


Fig. 13.

available, suitable means for prompt re-fusing, and the like, constitute considerations which the eye of a practiced central station man immediately appreciates.

The tendency to-day is toward the use of the larger transformers which are inherently of higher efficiency; and it has become a generally accepted axiom that the less transformers used (provided such transformers are not in excess of the capacity needed) the better for the operation of the system; not only because of the higher efficiency obtained, but also because of the less time needed to care for a small number of large transformers, and because of the better regulation secured throughout the entire system.

Buffalo Electric Lighting Plants.

BY FRANK C. PERKINS.

BUFFALO is supplied with current for street arc lighting, commercial arc light and incandescent lighting by the Buffalo General Electric Company, of which Mr. Daniel O'Day is president and Mr. Charles R. Huntley is general manager.

The current for the city arc lighting is supplied by the Elk street station No. 1 (Fig. 1), and the Black Rock station No. 3 (Fig. 2). The commercial arc lighting and the incandescent lights are operated from the Court street station (Fig. 3).

The Buffalo General Electric Company has been very unfortunate

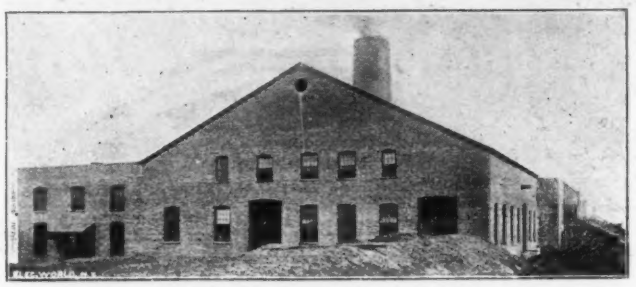


FIG. 1.—ELK STREET STATION NO. 1.

in having two serious conflagrations. The first at the Court street station No. 2 of serious proportions, and the last in February, 1893, almost completely wiping out the Elk street station No. 1 and necessitating extensive rebuilding and remodeling.

The steam boiler plant, Fig. 4, of the Elk street station consists of six National boilers of 125 hp each; two Babcock & Wilcox 250-hp boilers, and one 175-hp upright boiler; one 250-hp boiler built by the Oil City Boiler Works, and one 500-hp Scotch boiler, shown in the foreground of Fig. 4, made by the Lake Erie Engineering Works. The steam pressure is 140 lbs.

The engine room of this station, Fig. 5, contains two large E. P. Allis Corliss engines. The one shown in the foreground is a com-

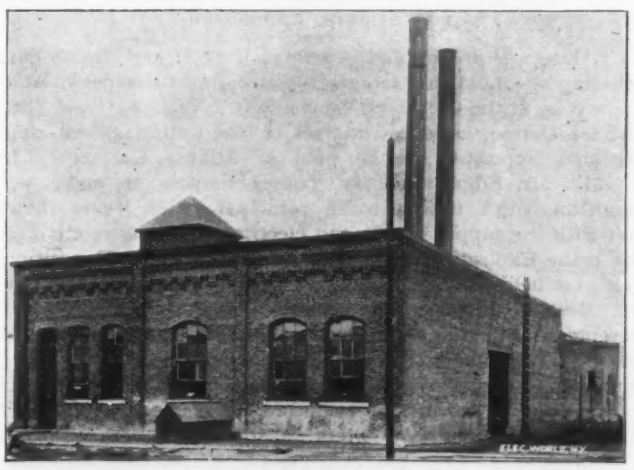


FIG. 2.—BLACK ROCK STATION NO. 3.

pound condensing engine, developing 1,500 hp at 68 revolutions per minute. The second engine is also a compound condensing engine, developing 1,000 hp at a speed of 72 revolutions per minute. E. P. Allis & Company's condensers are used in this station. The engines are belted to a long line of shafting located in the dynamo room beyond the brick wall seen in the background.

The arc machines in this station furnish current for all of the arc lights on the streets of the city. The dynamo room contains 39 No. 8 Brush arc dynamos of 50 lights capacity each, making the potential used on these circuits in the neighborhood of 3,000 volts.

There have also been installed five No. 11 Brush arc machines of a capacity of 125 lights each, making the working pressure about 6,000 volts. Mr. Huntley says these machines are working satisfactorily, and believes this to be one of the best arc lighting stations in the country. The Elk street station is about 250 feet long by

FIG. 3.—COURT STREET STATION NO. 2.

140 feet wide, and is a brick structure, having been remodelled in 1893. The original station was built in 1889.

The Black Rock station is also a brick structure, and is 150 feet long by 100 feet wide. The boiler room (Fig. 7) contains four horizontal tubular boilers, each of 100 hp capacity. From this station current is supplied to the arc lights located on the west side

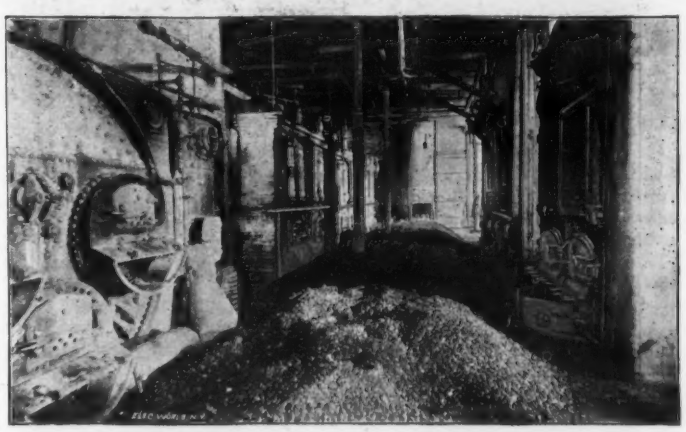


FIG. 4.—ELK STREET STATION BOILER ROOM.

of Buffalo and Black Rock. The dynamo and engine room (Fig. 8) contains four 60-light and six 80-light Wood arc machines. They are driven from a countershaft receiving its power from a compound condensing engine built by the John T. Noye Manufacturing Company, of Buffalo. This engine develops 400 hp at a speed of 300

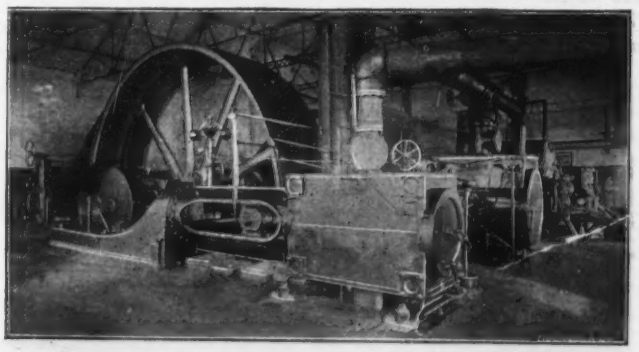


FIG. 5.—ELK STREET STATION ENGINE ROOM.

revolutions per minute. Worthington condensers are used in this station, and the plant is said to be giving excellent satisfaction.

The Court street station has been re-arranged since the fire, and it is from this station that all the commercial incandescent and arc lighting current is supplied. The dynamo room, as it is at present, is shown in Fig. 9. The power is supplied from eight compound

condensing engines built by the John T. Noye Manufacturing Company, ranging in size from 100 hp to 400 hp; there is also a Westinghouse compound engine of 125 hp capacity driving two Thomson-Houston dynamos.

The electrical equipment of this station comprises two 300-kw

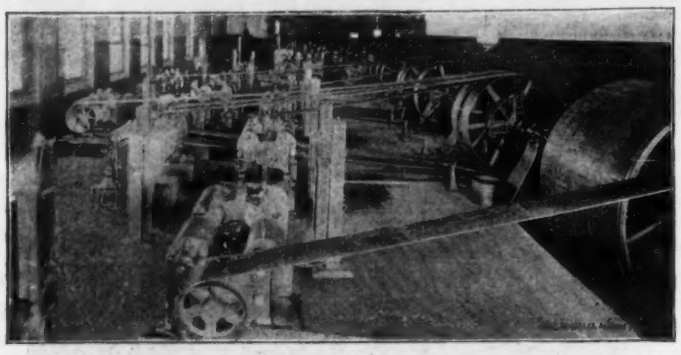


Fig. 6.—Elk Street Station Dynamo Room.

alternators of 6,000 lights capacity at 1,040 volts potential, three 70-kw alternators of 1,500 lights capacity, and two 60-kw 1,200 light machines, all of which operate at 1,040 volts.

There are two direct current General Electric dynamos which supply incandescent lights to customers in the immediate vicinity of

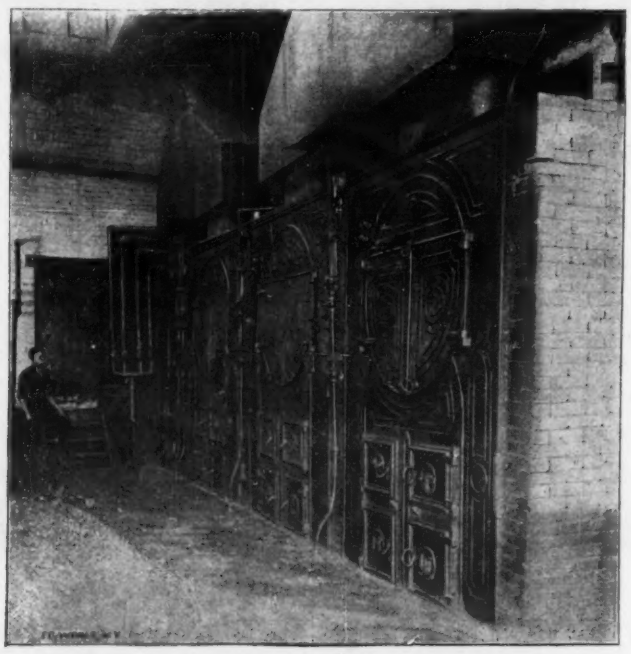


Fig. 7.—Black Rock Station Boiler House.

the station. These machines operate 400 lights each as a potential of 110 volts.

The power circuit is operated by a General Electric power generator, developing 200 kw at 500 volts. The arc lighting dynamos

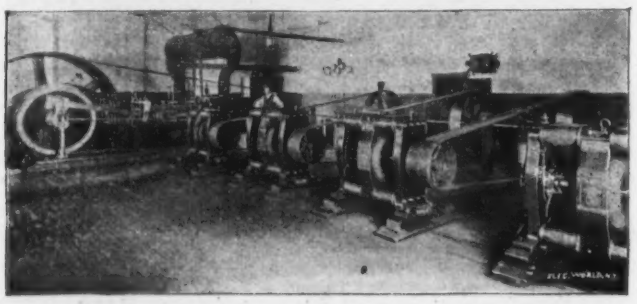


Fig. 8.—Black Rock Station Dynamo Room.

are all Thomson-Houston machines, and several are driven in tandem from John T. Noye high speed engines. There are eleven of these arc machines installed, each furnishing current for 50 lamps.

The Buffalo lighting stations are all generating steam power as economically as almost any station of the size, and while much talk has been indulged in with reference to operating the stations by power from Niagara, this will largely depend upon how much lower than the cost of steam power the price of Niagara power will be placed for users in the city of Buffalo.

In reference to the most practical means to be employed for utilizing the Niagara plant for lighting Buffalo, and the reason why such a low frequency was adopted by the power company, Prof. George Forbes says, in his paper before the Institution of Electrical Engineers, London, England: "Here is one fact which is apt, at first sight, to impress one as almost fatal to the employment of a very low frequency, but which further consideration shows to be of little moment in the case of Niagara Falls; that is, that a low frequency is not suitable for electric lighting directly. But it must be remembered that it is decidedly preferable to use a direct current for arc lamps, and, in fact, in the present position of the art in America,

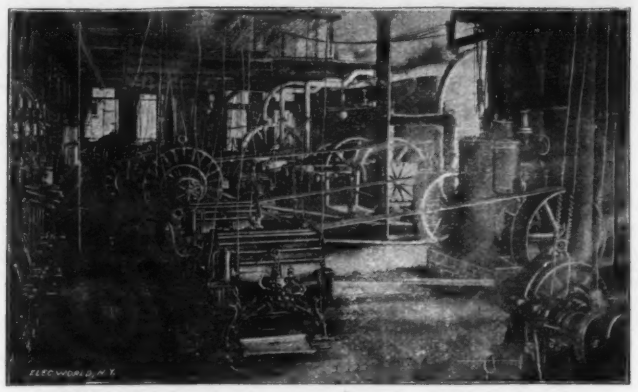


Fig. 9.—Court Street Station Dynamo and Engine Room.

it would be almost a necessity. Hence the natural method of lighting would be to use the alternating current by means of a motor to drive the well-known lighting machines. In the course of the work at Niagara, the first work in connection with arc lighting which will be set up is the lighting of Buffalo. At present this is done by means of steam engines developing about 3,000 hp, and driving arc lighting machines of the Brush, Thomson-Houston and Wood type. There cannot be a doubt that financially and practically the best way of converting this station to enable them to use the power from Niagara Falls is to put in alternating motors in the place of steam engines; and this will be the case in most of the towns which will be supplied with power from Niagara Falls."

It is generally believed that Prof. Forbes' plan will ultimately be adopted, the engines being held in reserve in case of emergency.

The Atlanta Exposition.

H. T. Edgar, secretary and general manager, and Oscar Turner, purchasing agent, of the Georgia Electric Light Company, Atlanta, Ga., will be at the Cleveland Convention of the National Electric Light Association, as representatives of the Cotton States and International Exposition, to be held at Atlanta, Ga., Sept. 18 to Dec. 31. Mr. Edgar and Mr. Turner propose to make a trip through the North, taking in the principal cities, where they will confer with the supply houses and electric companies relative to exhibits at the Exposition. It is purposed to make this Exposition the largest ever held in this country, with the exception of the World's Fair. Most of the European and South American countries will be represented. A separate building has been set apart known as Electricity Building, where electrical exhibits will be shown. The generating plant for the purpose of lighting the grounds and buildings and furnishing power will be located in the machinery hall. These gentlemen will have headquarters at the Hollenden, where they will be prepared to meet electrical people and arrange for exhibits, etc.

Fireworks in an Underground Railway Conduit.

Our special correspondent in Budapest writes us that some time ago a peculiar accident happened to an electric car on one of the main thoroughfares of Budapest. A chain supporting the sliding contact of a motor car fell through the conduit slot and lodged between the two contact rails in the underground conduits, making a dead short circuit. An attempt was made to dislodge the obstruction with a cold chisel, but without avail, and it was only after about one and a half hours' interruption in the traffic that the chain was burned away by the current, making a fine display of fireworks.

Coal Consumption in Central Stations.

BY E. A. MERRILL.

We define *coal consumption* as the total amount, measured by weight, of commercial coal—not combustible—thrown into the furnace for the production of steam to be used either directly or indirectly in the generation of electricity; it therefore includes the coal represented by the steam used in the pumps, condensers, purifiers, heaters, jackets, etc., and the coal rendered commercially unavailable in blowing off and cleaning boilers, getting up steam with new fires and making forced draught; it excludes coal represented by the steam used in heating, ventilating, etc.

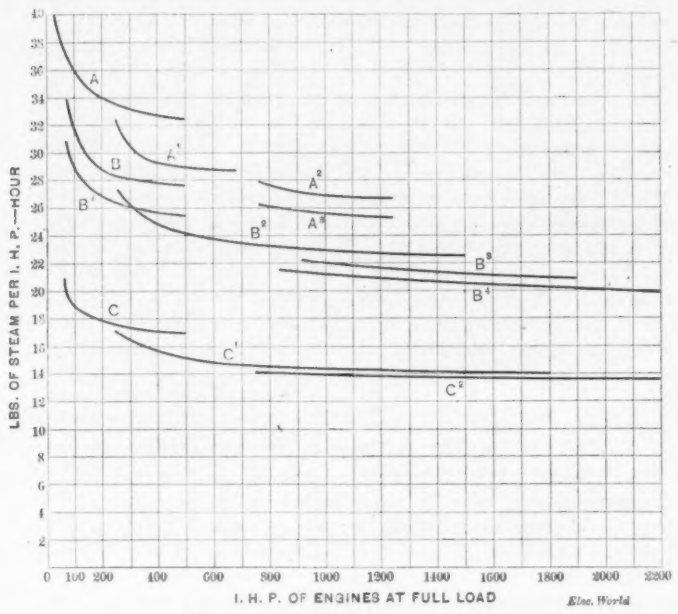


FIG. 1.

We define *central station* as a combined steam and electrical plant for the production of electrical energy to be utilized for lighting or power; this limitation being made arbitrarily to confine the scope of the article.

One of the principal problems that confronts the central station manager is to make the transformation of potential energy of coal into the kinetic energy of electricity with as little loss as possible—in other words to deliver at the switchboard the largest possible output in electrical energy with the least possible consumption of coal; the first step toward its solution lies in the determination of the relation between *input* and *output*; not between the coal scales and the water meter, not between the throttle and the driving pulley, not between the dynamo pulley and the armature terminals, but between the coal shed and the switchboard, including all the intermediate devices with their interdependent causes and effects.

To exhaustively discuss the questions involved would require a treatise, we therefore limit this brief discussion to certain specific cases outlined in the following table; each column represents the characteristics of what may be termed a type of station, these types having been selected as representing closely enough for comparison the equipment of a large number of central stations.

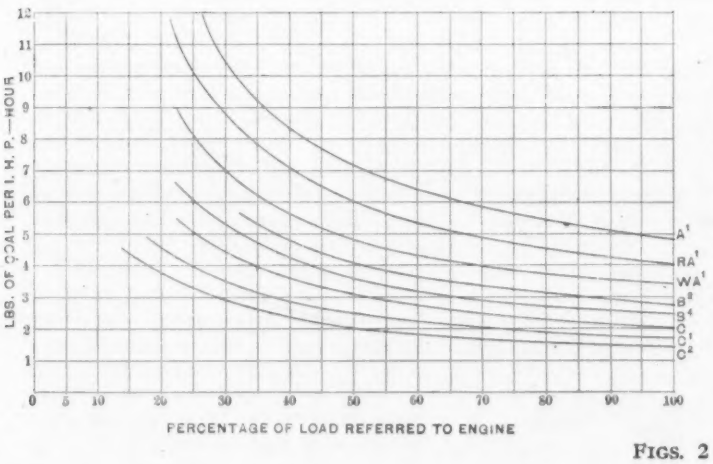
CURVE.	*A*	*RA'*	*WA'*	B^3	B^4	*C*		C^2
H. P. of Units	100 to 200	250 to 500	250 to 500	300 to 500	500 to 800	300 to 500	500 to 800	2000
Type of Engine	Simple Non-condensing.			Compound Non-condensing.		Compound Condensing.		
Steam pressure	80	80	80	100	140	120	120	150
Steam i.h.p. and hour	35	30	30	25	22	17	15.5	13.6
Type of boiler	R T	R T	W T	W T	W T	W T	W T	W T
Available B. T. U. per pound coal	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12 500
Evaporation at given pressure	7.5	7.5	9.	9	9	9	9.25	9.25
Eff. boilers—per cent	60	60	72.4	72.4	72.4	72.4	74.4	74.6
" engines—per cent	85	88	88	88	90	88	90	92
" piping—per cent	99	99	99	99	99	99	99	99
" miscellaneous—per cent	97	98	98	98	98	91	92	93
" belts—per cent	97	97	97	97	98	97	98	98
" dynamos—per cent	91	92	92	92	93	92	93	94
" leads—per cent	99	99	99	99	99	99	99	99

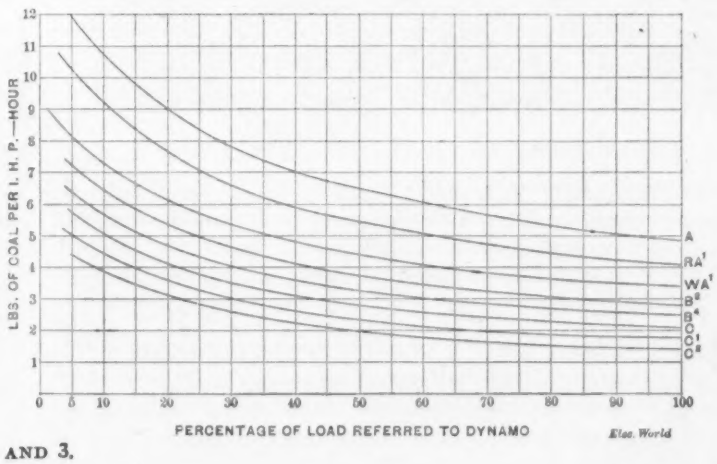
It must be confessed at the start that comparisons are at best faulty and to that degree unsatisfactory, but there is much to be learned from comparisons—experience is essentially comparison—therefore the more carefully and accurately they are made the more extended our knowledge becomes. How, then, can we compare central stations so as best to derive knowledge from the experience of others?

First by classifying them by some easily recognized characteristics and second by dividing and sub-dividing these classes into such small divisions that all stations in the same group can be compared with each other without doing serious injustice to any individual.

Comparisons between divisions having diverse functions and operating conditions are hardly more than rough generalizations; to call them comparisons is liable to give the results fictitious values and to establish false standards of central station economy. Even comparisons between sub-divisions are far from satisfactory, for they vary widely in their elements.

To go at once to the root of the whole matter, the most essential and valuable comparisons, so far as managers of central stations actually in operation are concerned, are either between stations which can be reduced to a practical equality of equipment and operating conditions, or between actual stations and an artificial standard attainable by a, commercially speaking, perfect station of the same type. When a station is once in operation it is far more to the manager's interest to know that his eight pounds of coal per kilowatt and hour cannot be bettered by any similar station, than to know that his neighbor in the next town with a different equipment and service gets the same output on six pounds, and vastly more satisfactory if he further knows that his neighbor ought to get the same output on five pounds; a good manager is not one who gets a larger output per pound of coal than his neighbor, but one who gets the largest output possible with his station. Comparisons between stations without discrimination as to equipment or operating conditions are responsible for a great deal of unmerited praise and undeserved adverse criticism.





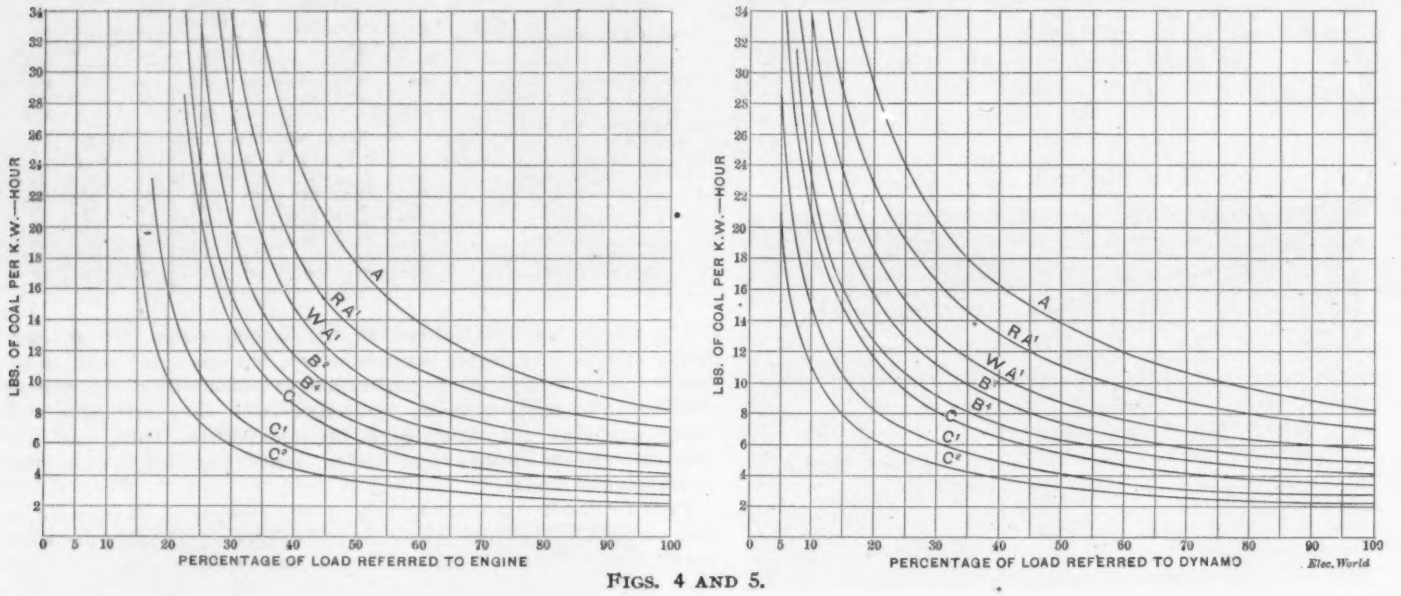
FIGS. 2 AND 3.

On account of the many variables to be taken into consideration it is by no means an easy matter to determine what output a station should have; take for example the engine—Fig. 1 gives a series of economy curves of engine listed by a single manufacturer; all the

engines are of the shaft governor, positive valve motion type, and the smaller ones are of the so-called high-speed class. The A's are single cylinder, non-condensing engines; the B's are compound non-condensing; the C's are the compound condensing. We see that there are wide variations in economy, even among engines distinguished by the same letter; these variations are due to differences in size, valve gear, clearances, steam pressure, cylinder proportions and ratios, speed and minor constructional details.

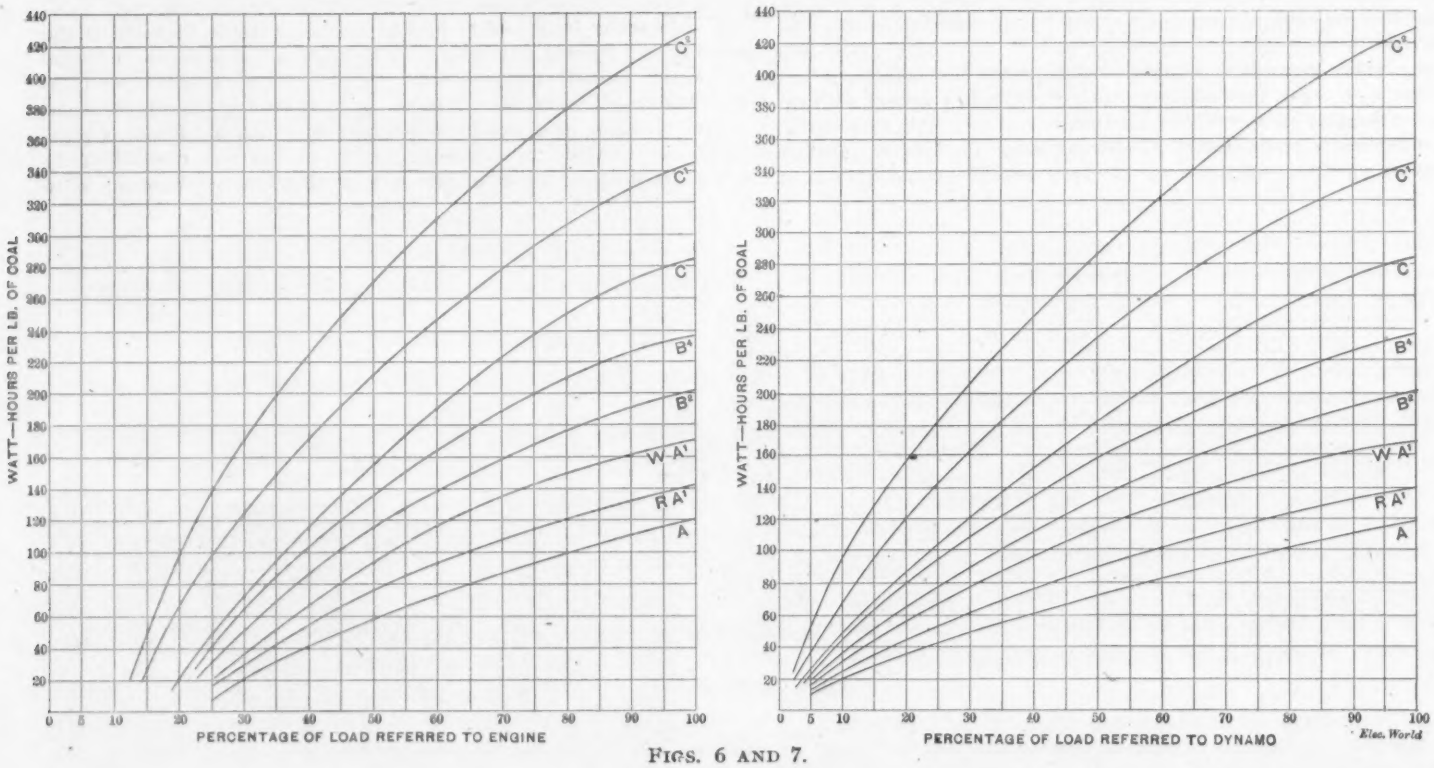
Similar differences, not always so wide, occur in every kind of apparatus that goes to make up the complete station equipment, so that it is necessary in determining the possible output from a given station to explicitly define the quantities involved.

The letters at the top of the table refer to the curves in Figs. 2 to 7 inclusive, and also indicate by reference to Fig. 1 what engine is assumed to be used; the R and W before A^1 indicate that in one case the station is equipped with horizontal return tubulars and in the other case with horizontal water tube boilers, the remainder of the equipment being identical in both stations; the same boiler division is also made by the letters R T, and W T, under "Type of Boilers." The number of available thermal units, 12,500, is taken as the value of a good grade of coal, and is necessarily made uniform for all the stations; the fact that the output is a direct function of the steaming value of the fuel is a point that seems often to escape notice. The efficiencies, with the exception of miscellaneous efficiencies, we believe do not require explanation; the percentage under miscellaneous efficiencies is the ratio of the thermal value of the steam received by the engine cylinders to the thermal value of the steam delivered by the boilers, the difference having been lost through radiation, condensation in piping and jackets, blowing off, etc., or utilized in operating feed pumps, condensers, traps, forced draught, etc.



FIGS. 4 AND 5.

Assuming that the parts are all so proportioned that at full load every part fulfills the conditions laid down in the table, we have the necessary data to determine the full-load economy of the several stations; with an efficiency curve of each part over the range of load selected for each station we have the necessary data for determining the economy at any specified load and all the curves in Figs. 2 to 7 inclusive have been derived in this manner. At best they hold true only for the conditions assumed, nevertheless we believe that they are in the direction of a true measure of the comparative fuel economy of central stations and that a comparison of the figures here given with results from the actual operation of stations somewhat



FIGS. 6 AND 7.

similar in equipment will indicate some of the reasons for the observed wide variations in fuel economies.

In reference to the curves the following explanation must be kept in mind: no curve represents throughout its length a single station. At full load the efficiencies given in the table are used, but for all other loads the curves are intended to show the probable fuel consumption for stations having similar equipments, but the efficiencies of stations that are operated at the percentage of load selected, each curve representing the sum of different portions of the curves of four and sometimes five distinct stations having similar equipments but different average loads and efficiencies. For example, curve A covers four distinct stations each having the units and the equipment specified in column A of the table; it also has the efficiencies there given at full load; as the load decreases, however, we assume that a station that is operated, say, at an average of 60 per cent. of its total dynamo capacity, does not have the same painstaking care and thoroughness in details as a station operated at a higher average load and, therefore, will not have so high an efficiency even at the same load, so that if we should continue the curve of the 60 per cent. station from the 60 per cent. point it would fall below the actual curve for higher percentages of load and rise above it for lower percentages. The extension of all these curves would cause unnecessary and undesirable confusion, and we have therefore carried each station over a moderate range of load and then combined these in a single curve.

The final standards of fuel economy will probably be based largely on practical results rather than on theoretical considerations, but before that is possible many reforms must be initiated and carried out through the active co-operation of station managers, first and foremost among which is the absolute necessity of comprehensive and accurate records reported in detail, together with a complete description of the station and its operation. The initiative should come from station managers, as they are the ones most deeply interested, yet we venture to suggest that if they will proceed at once to define to what part of the station equipment the percentage of load shall be referred, to define between what limits economy shall be measured, and to accompany their reports with a full description of the station, much of the fog of misunderstanding that now surrounds the subject will be dissipated.

Except at full load the percentage of load will not be the same on any two parts of the station equipment but will decrease with every transformation between the furnace and the switchboard, therefore the general term "load" can be applied to the station as a unit only in a general way; if we wish to be specific we refer the load to some particular portion of the equipment and custom has determined that this shall be either the engine or the dynamo--but *whether* the engine *or* the dynamo is a distinction seldom made and much confusion has resulted therefrom. For example, take curve A in Figs. 4 and 5;. when the engine is indicating 50 per cent. of its full load the dynamo is delivering but 35½ per cent. of *its* full load, the difference being lost in increased percentages of friction and heat losses between the engine cylinder and the dynamo terminals; going backwards, when the dynamo is delivering 50 per cent. of its full load the engine must be indicating 60 per cent. of *its* full load in order to supply the increased losses between dynamo terminals and engine cylinder. The natural way seems to be to refer the load to the dynamo, as it is with the dynamo output that we are most immediately concerned; the coal consumption per i. h. p. and hour is, nevertheless, of considerable importance and ought to be determined in every station at certain regular times, but rather for purposes of internal economy than for comparison with other stations.

The limits between which economies shall be measured while perhaps not so indefinite is certainly in as chaotic a state so far as uniformity is concerned. We mean by this that if you ask a manager what the proper way to measure the fuel economy of his station is the chances are that he will tell you, if he tells you anything, that the best way is to divide the total kilowatt hours delivered by the total coal used and thus ascertain the kilowatt hours per pound of coal; but if you look over his reports the chances are that his results are in terms of electrical horse-power hours, indicated horse-power hours, ampere hours, lamp hours, in fact anything *except* kilowatt hours; furthermore, if they are in ampere hours he probably has omitted to note the voltage or, still worse, if in lamp hours he probably has omitted the watt rating of the lamps and has assumed a value for arcs and motors connected just as large as his conscience will allow.

Certainly much of this confusion and inaccuracy can be avoided by stating the station load in terms of the dynamo load, stating the output in kilowatt hours and stating the fuel consumption in pounds of coal per kilowatt hour, as in Fig. 5.

While we prefer to state the fuel consumption in terms of pounds of coal per kilowatt hour, yet as an efficiency curve showing the increase in fuel economy with increasing load the curves in Figs. 6 and 7 in terms of watt hours per pound of coal are more graphic but must be used cautiously for the reason stated above, that the curves are not curves of a single station; these curves also emphasize the now pretty generally accepted fact that there is a largely increased profit in business that brings up the average load and that any system which permits a steady load at the maximum economical capacity of boilers, engines and dynamos is worth investigating and trying thoroughly.

But the points we wish here to emphasize most of all are that stations should not be compared indiscriminately, that to make comparisons valuable they must have some common basis, must be comprehensive, must be accurate, and that there is no better method of checking up coal consumption than by comparisons intelligently made.

Iron-Armored Conduit Construction.

BY GEO. T. HANCHETT.

Iron-armored conduit is beginning to reap the benefits of the labor and advertising that have been expended to set it before the public.

The fact still remains that it is almost impossible to get uniform bids on any large contract involving this material, and this would augur that contractors are unfamiliar with it. Closer inquiry shows this to be the case and, therefore, the following description of an iron-armored conduit job may not be amiss.

The second job of this class of any magnitude in New England is that installed in the Broad Street Power Company's office building at Pawtucket, R. I., William R. Walker & Son, architects, Chas. O. Lenz, electrical engineer. A general street view of the building is shown in Fig. 1. Iron-armored conduit has here been put to quite a severe test as to practicability and convenience of installation.

The building is wired on the meter system, every one of the numerous stores and offices having a separate line, finding its terminus at a meter room in the basement. This involves a bunching

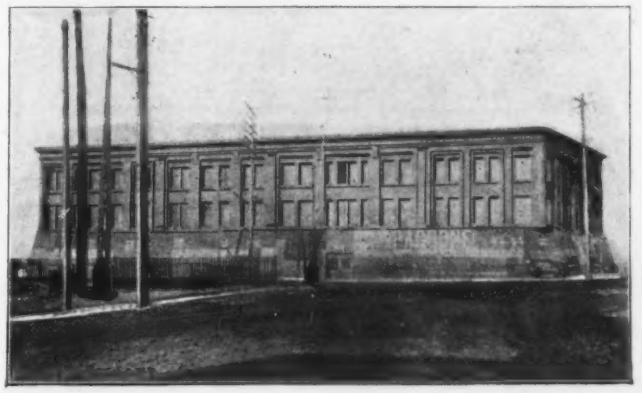


FIG. 1.—BROAD STREET POWER COMPANY'S OFFICE.

of tubes as the meter room is reached, and this, with the fact that the building is piped for gas on a similar system emanating from the same meter room, demonstrates that a great number of tubes in a limited space can be readily installed in iron as well as in brass-armored conduit in spite of the great rigidity of the former.

The manipulation of this conduit is in no sense of the word a plumber's job, as many contractors are inclined to think. Pipers and plumbers can be trained more readily to do the work, but experience and care only are necessary. The fact that the tube is lined with an insulating and more or less perishable conduit calls for careful work. Especial care should be used in cutting off the conduit. The wheel pipe-cutter may be used on the iron armor but should not be allowed to complete the work.

As soon as the cutter has nearly reached the insulating conduit it should be removed and the work finished with a hack saw; the end should then be carefully trimmed with a knife or reamer. This caution may seem one of the standard rules of conduit installation, but in the case of iron-armored conduit the great rigidity of the work and the difficulty of opening joints once installed imperatively demands that the joints have no burrs or obstructions to fishing.

Of course, it is necessary to test out every run with a fishing snake

as soon as it is in place, and it is better to run the spring wire through each piece of conduit before it is used—especially the elbows—as obstructions may exist inside. It should be remembered that in bending iron-armored conduit the insulating tube is rigidly controlled in its position by the iron armor and is therefore more liable to splinter and crack than if it were incased by a yielding brass armor.

The joints should not be too tightly screwed together. The soft insulating material is sure to yield under powerful screw pressure

FIG. 2.—BUCKLED JOINT.

and thus buckle the conduit, as shown in Fig. 2. This would present a serious obstacle to fishing the wire through.

The necessarily large size of the iron-armored conduit is somewhat unfortunate; the additional thickness of the armor and the necessity of installing two wires in one conduit contribute to this evil, and there is a resulting temptation on the part of the contractor to cut away and seriously weaken beams to admit the conduit. To the credit of contractors Scannevin & Potter, be it said, this was largely avoided in the construction of the Broad street station building.

It may be added that two wires in one conduit are *necessary* only in alternate current installations, as in that case two conduits would cause a large inductive drop which no amount of copper could eliminate. The advantage of two iron-armored conduits to one run is inappreciable and in no way comparable to the extra cost involved.

The elbow outlets of the conduit are especially in the way where it is desired to screw a switch or crow foot. In the building under discussion the device shown in Fig. 3 has been used and bids fair to be very successful. A wooden box lined with asbestos is set in the wall into which the conduits enter, and is covered with a beveled piece of mahogany on which the switch is mounted. This makes a neat outlet, almost equal to the standard junction box and costing much less. Asbestos-lined boxes have been utilized also for

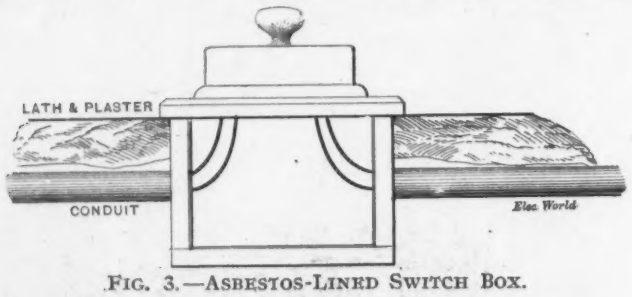


FIG. 3.—ASBESTOS-LINED SWITCH BOX.

large junction-boxes in the basement for the purpose of relieving the long pulls.

In conclusion, there is one item of interest to be mentioned, namely, the cost of iron-armored conduit construction. The material is a little more than twice as expensive as brass-armored conduit and the labor of installation about twice as great. Two wires in one conduit, however, halves the material and labor, so that the actual cost of an installation is but little more.

A comparison of the largest number of bids obtainable shows that iron-armored conduit construction is about 15 per cent. more expensive than brass-armored. However, the iron conduit has not been long enough on the market to thoroughly settle this figure. The cost per outlet is, of course, a variable figure, but at present, as nearly as may be judged, it is from $6 to $10, according to circumstances.

The fire-proof, nail-proof, and general all-around-proof qualities of the conduit seem to justify the extra expense. It has one other virtue—the care necessary in putting it up so that it will pass inspection is a brake on the workman. The nature of the work renders it slow and deliberate, so that he cannot rush it and botch it.

Consumption of Platinum.

According to *Industries and Iron* about three tons of platinum are used annually in America for the manufacture of incandescent lamps and other electric purposes, while one ton is used "for the more prosaic but no less useful purpose of being made into parts of artificial teeth."

What Shall We Pay Our Firemen?

BY J. B. CAHOON.

One of the things that is assuming more and more importance as time goes on and we become more familiar with the operation of an electric light station and see through just what means we can produce electric light and make it pay is the question of firemen and what we shall pay them in order to obtain economical and satisfactory results. If we divide the country up into sections and look each section over carefully with a view to ascertaining what is paid to the firemen in each of those places, we find that in all of them, outside of the larger cities, the pay ranges from $40 to $50 a month. Let us go into this matter a little more in detail and see what this means. Suppose we take the average and call it $45 a month, which the fireman gets for working every day in the week and every week in the month; we may call this $1.50 a day. For this wage a great majority of electric light plants seem to think that they can get a man who will run their fires in an intelligent and economical manner. We know that in any of our cities the day laborer in the streets who does nothing but shovel dirt gets as much as this. We know that shoveling dirt doesn't require a great amount of intelligence, and as labor is supposed to be paid pro rata according to the amount of intelligence entering into it we would naturally look for about the same intelligence in our firemen as we find in the day laborer in a city street; we all know about how much intelligence that is. Is there any reason then for being surprised that the operating expense of many of our electrical plants runs up to 80 to 90 per cent. of the gross income, although it may be said in this connection that in quite a number of good-sized country towns the operating expense often falls as low as between 60 and 70 per cent. of the gross income? In many cases where we find the latter result it is due largely to the fact that the fireman, while not paid so very much, is drawn from the country neighborhood. We may, however, set it down as a general rule that firemen are drawn from the foreign laboring class, it being in many cases practically impossible to get a native-born American to act as a fireman at the wages which are offered.

A few nights ago I stood in an electric light station watching the fireman at work and found that by the way he was firing he was using fully one-third more coal than there was any necessity for. I drew him into a conversation and asked him why he carried so thin a fire and spread the coal on to the hottest part of it without any attempt to coke it, this particular coal being very rich in hydrocarbons, He said he "didn't know of any reason for it except that it was easier to slice up, and very much easier to take care of." He had no idea how much coal he was burning, as he never troubled to weigh it; the bunkers being near the furnace, he simply shoveled the coal from the bunkers into the furnace as the latter seemed to need it. This man was paid $40 a month, and seemed to be satisfied with his work, and thought his pay was very fair. I thought it was for that kind of a man; but that isn't the kind of a man that we want for a fireman. We want men like they have in New York, who can obtain at least $60 a month, and who will get an indicated horse power per hour from a little over two pounds of coal, rather than a man to whom we pay $40 and who gets an indicated horse power running condensing, the same as the other, with 6.8 pounds of coal. These two instances mentioned are quoted from actual figures and are not mythical in the least. It seems to me that if managers of electric light plants would carefully consider this matter they would see that in a great measure it depends on the amount of coal they consume as to whether they are dividend payers or not. The two great items which enter into the operating expenses each month are wages and coal. Suppose now that we are using in a certain station 300 tons of coal per month at $3 per ton, which makes an item of $900; we employ three firemen and pay them $40 per month each, or $120 for the three; we find by actual experience that running condensing these three firemen will use six pounds of coal per indicated horse power per hour. Suppose we change our firemen and put in three at $60 per month each and we find that they furnish us our horse power at the rate of four pounds of coal per indicated horse-power per hour. Let us see how this figures up. Our coal drops to 200 tons at $3 per ton, or $600; our three firemen add $180, making a total of $780, as against $1,020 in the first instance; or in other words, by putting in a much higher grade of fireman, one who exercises an intelligent supervision over his coal consumption, looks after his boilers, sees that they are in proper steaming condition, and that everything inside and outside is as it should be, that the proper depth

of fire is carried and proper amount of draught is given, we find that our wage item, while more expensive, has saved us enough in coal to add materially to our dividends. Suppose now we go further than this and establish a base rate of $2 per day for each fireman, and say to the fireman, "We have found by actual trial that you average with this kind of coal four pounds of coal per indicated horse power per hour; now if you will keep up that horse power on a less amount of coal we will pay you $2 per day and one-half of the value of the difference in coal that you actually use and the four pounds which you have been using." In other words, "If you will save one pound of coal and get the same indicated horse-power with three pounds as you have formerly done with four, we will pay you the value of one-half of the difference between three and four pounds." Suppose by careful watching, looking after all the little leaks and keeping things up in first-class shape the fireman does get down to this, it saves us a pound of coal per indicated horse power. We add to their salaries one-half of this and we practically put the other half in our own pockets; or in other words, it is costing us at the rate of three and one-half pounds of coal per indicated horse-power, and we are making by the operation as clear gain one-half pound of coal per every indicated horse power, which reduced to dollars and cents, according to figures above, adds another $75 to our net earnings. By this arrangement it is barely possible that the firemen may make considerably more than the engineer, for as will be seen, by saving a pound of coal they will get as a bonus for distribution among them $75, or $25 each, which, added to their original base-rate of $2 per day, makes $85 per month as their total pay, and we in the meantime have effected by this change a saving of $315 per month in our coal bill and wages of firemen combined.

I fully realize that a good many station managers will be inclined at first thought to disagree with me on this, but I can say in reply that this is not drawn from my imagination but is based on actual facts and principles of to-day. Of course, it is necessary to find intelligent, capable and first-class firemen in the first place, and then time and trouble must be taken to find out the best quality of coal for your particular work, and your engines must be indicated carefully with the different loads, so that you may have a fair idea of what the actual indicated horse power used at different times during the day would amount to, and figure up carefully the amount of coal consumed, based on the indicated horse power per hour as obtained from the indicator cards, and then you will be ready to talk business with your fireman.

It will be remembered that at the Electric Light Convention of last year a report was made on the number of watt-hours obtained per pound of coal from some sixty or more stations, and it may fairly be presumed that inasmuch as the subject attracted considerable attention a great many station managers have looked more closely into this matter since that time and are now keeping a record of the output of their station in total watt-hours. If this be the case, it will then be comparatively easy for them to base the rate of pay of their fireman on the increase in watt-hours obtained per pound of coal. This latter is really a much more reliable method than attempting to form an estimate on the indicated horse power consumed per hour, as this is subject to considerable fluctuations, and it would be too much trouble to many to take indicator cards sufficient to form anything like a very accurate idea of the total indicated horse power developed per hour at different times during the day and night.

In THE ELECTRICAL WORLD of May 5, 1894, the writer presented a diagram of coal consumption and watt-hours by means of which once having obtained the watt-hours per pound of coal or rate at which the coal is used, we can then from a total number of tons per day ascertain the total watt-hours per day, and conversely given the total output of the station in watt-hours and the coal consumption, we can obtain the rate from the diagram. This being a very simple method not involving any great amount of figuring affords a ready means of ascertaining at any time just how the fireman is doing, and I believe that if station managers will once take the trouble to familiarize themselves with this diagram they will find it of very great value. It is certainly more economical to employ first-class firemen in other ways than in the mere saving in the coal pile, for it will be found that with such a man the boilers and steam piping leading therefrom will receive intelligent and careful attention, and everything will be done that is possible for a man to do to increase the economy of the steam plant. There is one point that should receive careful attention from the station manager, and that is the condition of the engines, for if the valves are not properly set there is going to be a loss in steam at this point which will nullify possibly in a great measure the good results obtained from the employment of a first-class fireman. It is not enough to indicate the engines once a year, but the station manager should see to it that they are indicated at least every month, and oftener if he has the slightest suspicion that the engines are not doing their work properly. Another point that needs careful attention, and one which is apparently neglected in a number of stations, is the condenser, where the station is operating condensing.. If the station is to be operated in this way every effort should be made to keep the condensing part in thorough repair and first-class condition. Care should be taken to occasionally test the exhaust piping leading from engine to condenser to see that it is perfectly tight. If, after pump and engine are stopped and with all drip-cocks closed, the needle of the vacuum gauge will remain stationary for ten minutes or so, this is enough to show that everything is tight. If it is found that there are leaks in the piping they should receive immediate attention. At least 25 inches of vacuum should be maintained at all times when running, and the condensers should have just as much care and attention toward keeping them clean as is given to the engines.

In these days no electric light plant can be run without scrupulous attention to the minute details and minute economies that we used to formerly overlook.

Given ordinary favorable conditions money can be made in the electric light business if it is given the same careful attention and consideration as the successful merchant gives to his business; but if we let all the little economies slide and do not attempt to stop the leaks as they come along, we will find that the electric light business does not pay.

To sum up, slightly changing the old quotation, we can say that "If we look out for the pennies, the dollars will take care of themselves."

Practical Notes on Dynamo Calculation.—XXVII.

BY ALFRED E. WIENER.

(*c*) *Pedestals and Bearings.*

In the design of the base, especially when the portion of the field frame above the armature centre cannot be lifted off, care should be taken that the armature can easily be withdrawn longitudinally by removing one of the bearing pedestals, which, therefore, should be a separate casting. In machines where the lowest point of the armature periphery is in a considerable height above the base, as for instance in dynamos of the over-types,[1] Figs. 68, 71, 78 and 86 respectively, further, of the vertical double types, Figs. 77, 82, 87, 99 and 104, respectively, and of the radial and tangential outerpole types, Figs. 88 and 90, respectively, it is preferable that the pedestals should be made of two parts, the upper part, which should have a depth from the shaft centre a little in excess of the radius of the finished armature, being removable, while the lower portion, which may be cast in one with the base, will form a convenient resting place for the armature in removal.

In most cases this problem of making high pedestals of two parts can practically be solved by boring out the pedestal seats together with the pole pieces, thus providing a cylindrical seat for the pillow blocks, as shown in Fig. 118. This design is particularly advantageous also for machines in which the base forms one of the pole pieces, as for example, the forms shown in Figs. 73, 79 and 99, as in this case, outside of the finishing of the core seats, this boring to a uniform radius is the only tooling necessary for the base.

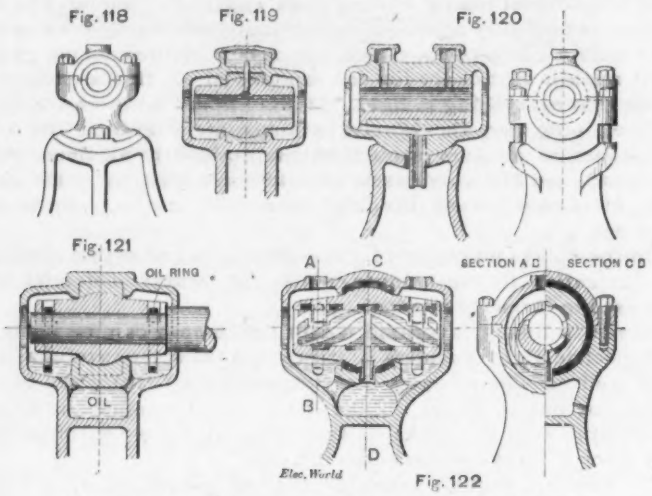
If the field frame is symmetrical with reference to the horizontal plane through the armature centre, the frame of the machine is usually made in halves, and the armature, in case of repair, can be removed by lifting it from its bed without disturbing the bearing pedestals. The bearing boxes must for this purpose be made divided so that all parts of the machine above the shaft centre are removable. This design affords the further advantage that the bearing caps can be taken off at any time and the bearings inspected, and it has for this reason become a general practice in dynamo design to employ split bearings, even for types in which the armature cannot be lifted.

It is further of great importance that the bearings should not only be exactly concentric, but that they also should be ac-

[1] In chapter 41, page 52, the names "*over-type*" and "*under-type*" were accidentally exchanged, the former corresponding to the *inverted*, and the latter to the *upright* single Horseshoe type.

curately in line with each other; for large machines it is therefore advisable to effect automatic alignment by providing the bearings with spherical seats. This can be achieved either by giving the enlarged central portion of the shell a spherical shape, Fig. 119, or in providing the bottom part of the box with a spherical extension fitting into a spherical recess in the pedestal, Fig. 120.

In order to prevent heating of the bearings the shells in modern dynamos are usually furnished with some automatic oiling device, the most common form of which, shown in Fig. 121, consists of a brass ring or chain dipping into the oil chamber



Figs. 118 to 122.—Pedestals and Bearings.

of the box and resting upon and turning with the shaft, thereby causing a continuous supply of oil at the top of the shaft. A further improvement of this self-oiling arrangement, patented in 1888 by the Edison General Electric Company, is illustrated in Fig. 122. In this the interior of the shell is provided with spiral grooves filled with soft metal and forming channels for conveying oil from each end of the bearing to a circumferential groove which surrounds the shaft at the centre of the shell, and which communicates with the oil chamber beneath the bearing. These grooves not only effect a steady supply but a continuous *circulation* of oil, the latter being lifted from the reservoir into the shell by the oiling rings, thence forced by the spiral channels into the central groove, from where it flows back into the oil-chamber.

Chapter 46—Joints in Field Magnet Frame.

(*a*) *Joints in Frames of One Material.*

Magnet frames consisting of but one material may either be formed of one single piece or may be composed of several parts. If the frame is of cast iron or cast steel, in small dynamos usually the former is the case, *i. e.*, the whole frame is cast in one, while in large machines it generally consists of two castings; if, however, wrought iron is used, it is, as a rule, much more convenient to forge each part separately and to build up the frame by butt-jointing the parts. In so jointing a magnet frame it is of the utmost importance to accurately adjust and finish the surfaces to be united, so as to make the joint as *perfect* as possible, for, every poorly fitted joint, by reduction of the sectional area at that point, introduces a considerable reluctance in the magnetic circuit. If, however, the contact between the two surfaces is as good as planing and scraping can make it, a practically perfect joint is obtained, and the additional reluctance, which then only depends upon the degree of magnetization, is entirely inappreciable for such high magnetic densities as are employed in modern dynamos. Experiments have shown that at low densities the additional magnetomotive force required to overcome the reluctance of a joint is very much greater, comparatively, than at high inductions, which is undoubtedly due to the pressure created by the magnetic attraction of the two surfaces across the joint, this pressure being proportional to the square of the density. The following Table LVIII. shows the influence of the density of magnetization upon the effect of a well-fitted joint in a wrought iron magnet frame, the induction in the iron ranging from 10,000 to 120,000 lines per square inch, and indicates that the reluctance of the joint becomes the less significant the nearer saturation of the iron is approached.

TABLE LVIII.—INFLUENCE OF MAGNETIC DENSITY UPON THE EFFECT OF JOINTS IN WROUGHT IRON.

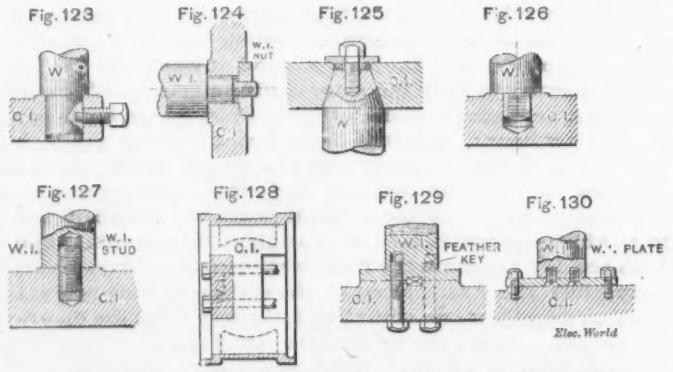
Density of magnetization. $\mathfrak{G}$ Lines per sq. in.	Pressure on joint due to magnetic attraction $\frac{\mathfrak{B}^2}{72{,}134{,}000}$ lbs. per sq. in.	Magnetomotive force required for 1 inch. Solid $\mathfrak{JC}_1$ Amp. turns	Jointed. $\mathfrak{JC}_2$ Amp. turns.	Difference due to joint $\mathfrak{JC} = \mathfrak{JC}_2 - \mathfrak{JC}_1$ Amp. turns.	Equivalent of Joint. Air space. $\frac{\mathfrak{JC}}{.313 \times \mathfrak{B}}$ Inch	Length of iron. $\frac{\mathfrak{JC}}{\mathfrak{JC}_1}$ Inch.
10,000	1.4	1.7	6.7	5	.0016	3.0
20,000	5.5	3.2	12.6	9.4	.00155	2.9
30,000	12.5	5	19.1	14.1	.0015	2.8
40,000	22	7	25.2	18.2	.00145	2.6
50,000	35	9.5	31.4	21.9	.0014	2.3
60,000	50	12.7	38.1	25.4	.00135	2.0
70,000	68	18.3	45.7	27.4	.00125	1.5
80,000	89	27.6	55.2	27.6	.0011	1.0
90,000	112	50.8	76.2	25.4	.0009	0.5
95,000	125	68	91.8	23.8	.0008	.35
100,000	139	90	110	20	.00065	.22
105,000	153	134	150	16	.0005	.12
110,000	168	288	300	12	.00035	.04
112,500	176	391	400	9	.00025	.023
115,000	183	500	506	6	.00016	.012
117,500	192	600	603	3	.00008	.005
120,000	200	700	700	0	.00000	.000

At a magnetic density of $\mathfrak{B}$=10,000 lines of force per square inch, each joint in the circuit is equivalent to an air space of .0016 inch, or has a reluctance equal to that of an additional length of 3 inches of wrought iron; at $\mathfrak{B}$=100,000 lines per square inch, the thickness of an equivalent air space is only .00065 inch, which corresponds to the reluctance of .22 inch of wrought iron at that density; and at or above $\mathfrak{B}$=120,000; finally, a good joint is found to have no effect whatever upon the reluctance of the circuit.

(*b*) *Joints in Combination Frames.*

For magnet frames consisting of two or three different materials the same rule as for frames of one material holds good as to the *nature* of the joint, but since the ordinary butt jointing would limit the capacity of the joint to that of the inferior magnetic material, it is essential in the case of combination frames to increase the *area of contact* in the proportion of the relative permeabilities of the two materials joined. Thus, if wrought and cast iron are butt jointed, the capacity of the joint is reduced to that of the cast iron, whereby the advantage of the high permeability of the wrought iron is destroyed and the permeance of the circuit is considerably increased; and in order to have the full benefit of the wrought iron, the contact area of the joint must be increased proportional to the ratio of the permeability of the wrought iron to that of the cast iron at the particular density employed.

For a density in wrought iron of 100,000 lines of force per square inch, for example, a magnetomotive force of 90 ampere turns is required per inch length of the circuit, and the same specific magnetomotive force is capable of setting up about 40,000 lines per square inch in cast iron; the contact area of a joint between wrought iron and cast iron in this case must therefore be increased in the ratio of 100,000 : 40,000, or must be made 2½



Figs. 123 to 130.—Joints in Magnetic Circuits.

times the cross-section of the wrought iron, in order to reduce the permeability of the joint to that of the wrought iron.

In practice this problem of providing a sufficiently large contact area between a wrought and a cast iron part of the magnetic circuit may be solved either by setting the wrought iron into the cast iron, or by extending the surface of the wrought iron part near the joint by means of flanges; or, finally, by inserting an intermediate wrought iron plate into the joint. In Figs. 123, 124, 125 and 126 are shown four methods of increasing

the area of the joint by means of projecting the wrought iron core into the cast iron yoke or pole piece, differing only in the manner of securing a good contact between the parts, the first one employing a set screw, the second one a wrought iron nut, and the third one using a conical fit with draw screw for this purpose, while in the fourth one the threaded projection of the core itself forms the tightening screw. Fig. 127 illustrates a modification of the method shown in Fig. 126, a separate screw stud being used instead of the threaded extension of the wrought iron core. In case of rectangular magnet cores the arrangement shown by plan in Fig. 128 effects an excellent joint; in this the cores are inserted into the base from the sides, thus offering three surfaces to form the contact area. The manner of supplying the necessary joint surface by flanged extensions of the wrought iron core is illustrated in Fig. 129, which shows the method of fastening employed in large multipolar machines, feather keys being used to secure exact relative position of the cores. In Fig. 130, finally, a joint is shown in which a wrought iron contact plate is inserted between the wrought iron core and the cast iron yoke or pole piece with the object of increasing the area of the joint and of spreading the lines of force gradually from the smaller area of the wrought iron to the larger of the cast iron.

(To be continued.)

Electrodynamic Machinery—XXVI.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

125. A given type of bipolar Gramme machine having proved satisfactory as regards efficiency, ease of running and cost, at a full load output of say 10 kw, it may have to be determined whether it would prove advantageous to maintain the same design for a machine of a greater output, say 80 kw. Let us assume that the linear dimensions of the 10-kw machine are doubled, with the same speed of revolution, say 1,000 revolutions per minute, maintained in the larger machine. Then, assuming the same magnetic intensity in the armature, the electromotive force will be four times as great, since the area of cross-section of the armature and, consequently, the total useful flux will be increased fourfold. The resistance of the armature will be halved; for, each turn, though twice as long, will have a cross-sectional area four times greater.

The electrical capability of the smaller machine being expressed by $\frac{e^2}{r}$ (Sec. 6), that of the greater will be $\frac{(4e)^2}{\frac{1}{2}r} = 32\ \frac{e^2}{r}$, or 32 times greater than in the 10-kw machine, and, if the same

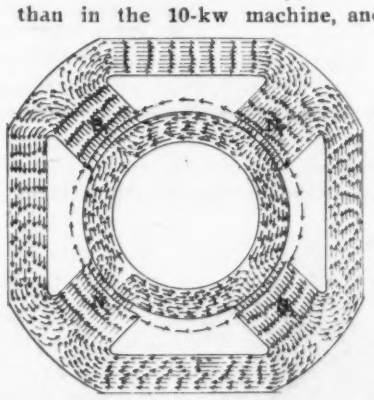


FIG. 111.—DIAGRAM OF MAGNETIC CIRCUITS IN QUADRIPOLAR GRAMME GENERATOR.

efficiency is maintained in the larger machine, the output will be 32 times greater. The weight of the larger machine would, of course, be eight times that of the smaller, and the output per pound of weight would, therefore, be four times greater in the larger machine. In reality, however, such a result is impracticable.

126. Dynamo machines are either belt-driven or direct-driven. In the case of direct-driven generators the speed of the generator is necessarily limited by the speed of the engine, and this, for well-known constructive reasons, has to be maintained comparatively low, and the larger the generator, the slower the speed of rotation that has to be practically adopted. Thus, while a 100-kw generator is commonly driven direct from an engine at a speed of about 250 revolutions per minute, a 200-kw generator is usually direct driven at about 150, and a 400-kw generator at about 100 revolutions per minute. In the case of belt-driven generators, the speed of belting is usually limited, except when driving alternators, to about 4,500 feet per minute; and, since larger generators require larger pulleys, their speed of rotation has to be diminished. While no exact rule can be applied for determining their speed, yet roughly, in American practice the speed varies inversely as the cube root of the output, so that, when one generator has eight times the output of another of the same type, the speed of the greater machine would roughly be half that of the smaller.

If no other limitation existed besides efficiency. the effect of doubling the linear dimensions of any generator, even taking the reduced rotary speed into account, would result in producing about 16 times the output for eight times the total weight; but large machines must necessarily possess a higher efficiency than small machines, not only owing to the fact that they would otherwise become too hot, since the surface available for the dissipation of heat only increases as the square of the linear dimensions, while the weight and quantity of heat increases as the cube of the dimensions, but also because large machines are expected to have a higher efficiency from a commercial point of view.

127. Taking into account, therefore, the reduced rotary speed of larger machines, their limits of temperature elevation, and their necessity for an increased efficiency, the output only increases approximately as the cube of their linear dimensions, and, consequently, the output of the larger machine, per pound of weight, remains practically the same as that of the smaller. The output of belted continuous current generators is commonly six watts per pound of net weight, and of direct-driven multipolar generators about eight watts per pound of net weight.

128. We have already seen (Sec. 115) that the E. M. F. generated by a Gramme ring armature is Φnw C. G. S. units, or $\Phi\ \frac{nw}{10^8}$ volts, and the resistance of the armature will be $\frac{R}{4}$ ohms, if R be the resistance of the winding measured all the way round. Supposing now, that instead of employing a bipolar machine, we double the

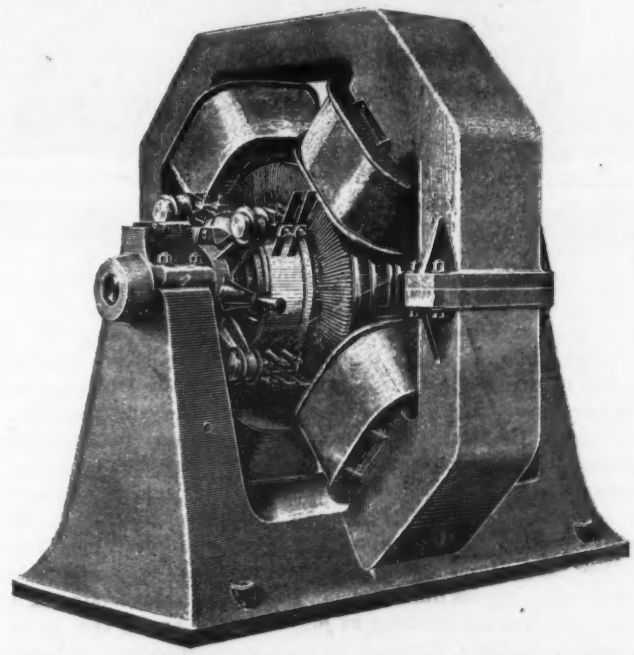


FIG. 112.—QUADRIPOLAR GENERATOR WITH GRAMME ARMATURE.

number of poles and produce a four-pole or quadripolar machine, as shown diagramatically in Fig 111. If we employ the same total useful flux, Φ, through each pole, the average rate of change of flux through the turns on the armature will be doubled, since the flux through any turn is now completely reversed in one half of a revolution, instead of in one complete revolution as before. The average E. M. F. in each turn will, therefore, be doubled. In Fig. 111, the magnetic circuits of a quadripolar Gramme generator are shown diagramatically by the flux arrows. Here, as will be seen, four distinct magnetic circuits exist through the armature, instead of the two which always exist in the armature of a bipolar generator. In this type of field frame, four magnetizing coils must be used. These may be obtained in one of two ways; namely,

(1) By placing the magnet coils directly on the field magnet cores, as shown in Fig. 112; or

(2) By placing one coil on each yoke, as represented in Fig. 113.

129. In the same way if we employ a field frame with six magnetic

poles, as shown in Fig. 114, the flux will be reversed through each turn of wire three times in each revolution and, consequently, the average E. M. F. in each turn will be increased three-fold over that on a bipolar armature. In Fig. 114 there are six magnetic circuits through the armature. Considering any segment of the armature underneath a pole as, for example, between n_3 and p_1 the turn occupying the position at n_3 is filled with flux in an upward direction. As the armature advances in the direction of the large arrows the flux through this turn will be diminished, and when it reaches the middle of the pole piece S_3, it will be completely emptied of flux. The E. M. F. in the loop, during this portion of the revolution, will be directed outwards on the ring, as shown by the double-headed arrows. After passing the centre of the pole piece S_3, the flux through the loop begins to increase, but now in the opposite direction, the flux passing downwards through the loop instead of upwards as before, and, as we have already seen, flux entering a loop in one direction produces the same direction of E. M. F. around the loop as flux oppositely directed withdrawing from the loop (Sec. 90). Consequently, the E. M. F. is still directed outwards on the ring, as indicated by the double-headed arrows, until the turn reaches the position as p_1. In other words, the E. M. F. in a loop is similarly directed by its motion towards and from the same pole, or, during its passage past a pole. When, however, the turn begins to approach the pole N_1, after being completely filled with the downward flux at p_1; *i. e.*, as the flux in it begins to decrease, the direction of the E. M. F. in it reverses, as shown by the double-headed arrows, and this direction of the induced E. M. F. continues until the turn reaches the position n_1. By tracing the directions of the induced E. M. Fs. in the various turns of the ring, as shown, it will be seen that the positions p_1 p_2 and p_3 are points at which the E. M. F. is positive or directed outwards, while the positions n_1 n_2 and n_3 are points at which the E. M. F. is negative or directed inwards. There will be no current passing through the armature in the condition represented if the winding of the armature be symmetrical, since the E. M. Fs. in the various segments must be equal and opposite. If, however, brushes be applied to the surface of the armature at the positions p_1 p_2 and p_3, and n_1 n_2 n_3, any pair of these including one positive and one negative brush will be capable of supplying a current through an external circuit.

130. When, therefore, an ordinary Gramme ring winding is employed, there will be one brush between each pair of poles or, in all, as many brushes as there are poles. Fig. 115 represents the connections employed to unite the various segmental E. M. Fs. The E. M. F. of the armature is equal to that of one of its segments, but the resistance of the armature is inversely as the number of segments and poles, and if R be the resistance of the entire armature winding, $\frac{R}{p^2}$ will be the joint resistance between brushes, for there will be p sections in parallel, each of which will have $\frac{R}{p}$ ohms, and consequently in a six-pole armature there will be six segments in parallel, each having a resistance of $\frac{R}{6}$, making the joint resistance $\frac{R}{36}$, or $\frac{R}{6^2}$.

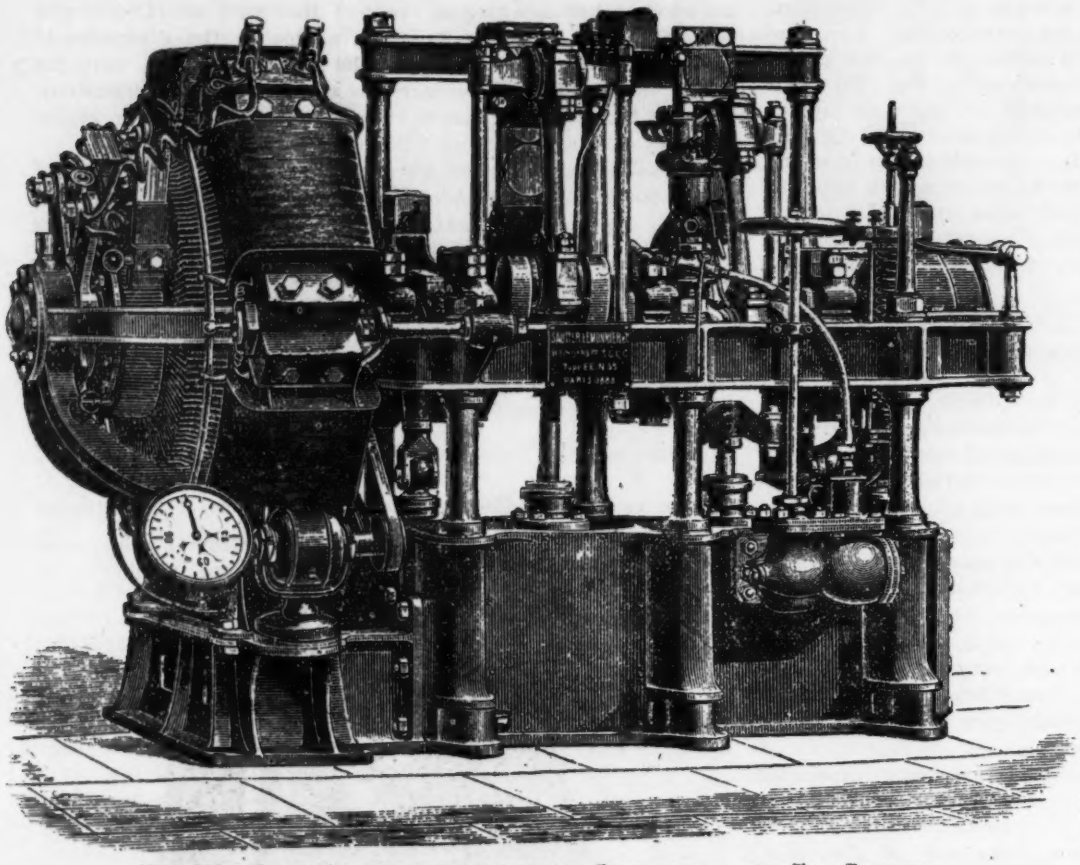


Fig. 113.—Quadripolar Direct-Driven Generator with Two Brushes.

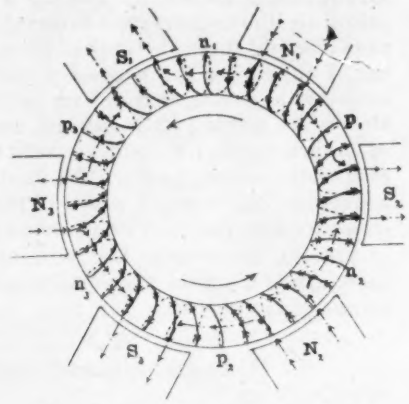


Fig. 114.—Diagram of Six-Pole Gramme Ring Armature and E. M. Fs.

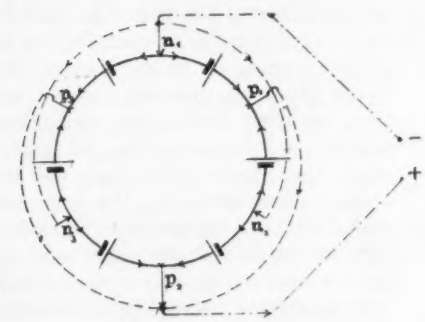


Fig. 115.—Diagram of Connections Between Brushes of a Simple Gramme Ring Winding of a Sextipolar Armature.

Fig. 116 represents the mechanical arrangement for rigidly supporting the armature of a direct-driven octopolar Gramme ring generator with eight sets of brushes pressing upon one side of the armature, thus dispensing with the use of a separate commutator. The central driving pulley *PPP*, supports upon its arched face two rings *RR'*. These rings clamp between them the armature core and are clamped together by 14 stout bolts. Where the supports *ss* interfere with the winding of the conductor inside the armature the conductors are carried on the supports as at *a b c* and *d*.

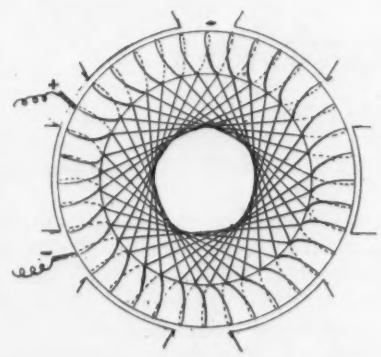


Fig. 117.—Armature Cross-Connections for a Sextipolar Gramme Ring with 2 Brushes.

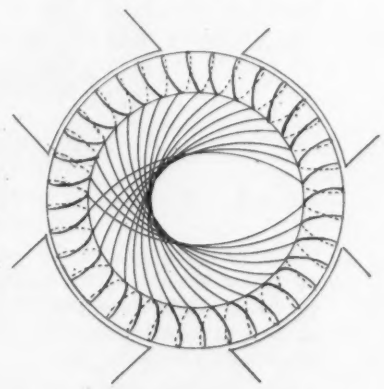


Fig. 118.—Cross-Connections for Quadripolar Gramme Ring with 2 Brushes.

132. It is not absolutely necessary, however, to employ six brushes in a sextipolar machine, for since in a machine of this type the three separate circuits are connected in parallel, connections may be carried within the armature between the various segments, thus permitting of the use of a single pair of brushes. Thus Fig. 117 represents a Gramme ring armature wound for a sextipolar field and with triangular cross connections between its turns. In this case the corresponding points p_1 p_2 p_3 and n_1 n_2 n_3 of Fig. 114, instead of being connected together by brushes externally as in Fig. 115 or 116, are connected together by wires internally. It is not, of course, neces-

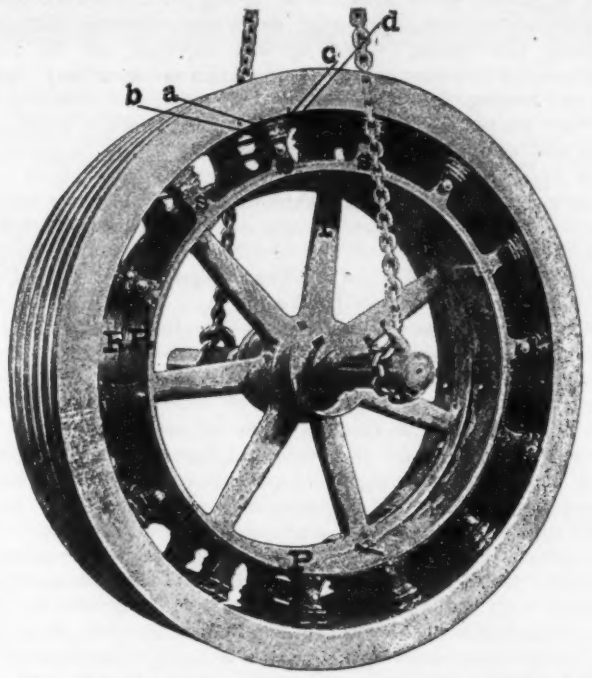


FIG. 116.—GRAMME RING MULTIPOLAR ARMATURE.

sary that every turn on the armature should be so cross connected, but that the coils or group of turns which are led to the commutator should be cross connected, so that each of the 36 turns shown in Fig. 117 may represent a coil of many turns. Although the brushes are shown in Fig. 117 as being placed on adjacent segments, yet they may be equally well placed diametrically opposite to each other.

Fig. 118 represents the corresponding cross connections for a quadripolar Gramme generator employing a single pair of brushes. The advantage of cross connections is the reduction in the number of brushes. The disadvantage of cross connections lies in the extra complication of the armature connections. In large machines it is

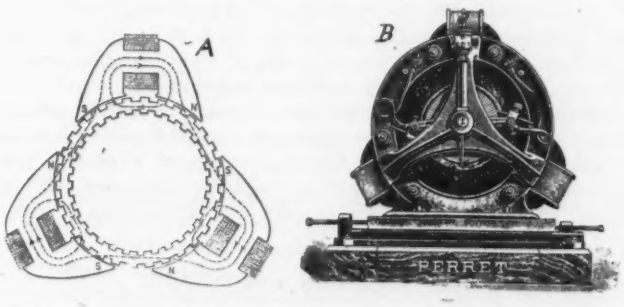


FIG. 119.—SEXTIPOLAR GRAMME RING SUPPLIED BY THREE MAGNET COILS.

often an advantage to employ a number of brushes in order to carry off the current effectively.

133. Fig. 119 is a representation of a sextipolar generator whose magnetic field is produced by three magnetomotive forces, produced by coils placed as shown. The flux paths are represented diagramatically by the dotted arrows at *A*. Each M. M. F. not only supplies magnetic flux through the segment of the armature immediately beneath it, but also contributes flux to the adjacent segments in combination with the neighboring M. M. Fs.

(To be continued.)

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Electrical Power Transmission.—XIV.

BY LOUIS BELL, PH. D.

As an example, let us suppose the case of a 1,000-hp transmission so constituted that the line copper costs $10,000 with 10 per cent. loss of energy in the line, and suppose in addition that the net value of one horse-power at the receiving end is $50 per annum. It is evident that by decreasing the loss in the line to 2½ per cent. there would be available 75 additional horse-power worth $3,750 per annum. The cost of this addition to the line would be $30,000, on which interest at 6 per cent. would be $1,800. So long as the plant is not worked up to 90 per cent. of its maximum capacity of 1,000 hp there will be a steady charge of $1,800 plus depreciation if the additional copper be installed at the start. A few months loss at this rate would more than cover the labor of reinforcing the line when needed, even supposing that the additional copper at the start would not have involved extra labor in construction.

Various formulæ for designing the line so as to secure the minimum cost of transmission have been published, derived more or less directly from Kelvin's law and attempting to take into account all the various factors involved in line efficiency. They all contain quantities of very uncertain value, and hence are likely to give correspondingly inexact results. More than this, they are founded on two serious misconceptions. First, they generally give the minimum cost of transmission, which is not at all the same thing as the maximum earning power on the total investment.

Second, however fully they take account of existing conditions, the data on which they are founded refer to a particular epoch, and hence are unreliable when applied to a permanent plant.

A few years or even months may and often do so change the conditions as to lead to a totally different result. In the vast majority of cases it is impossible to predict even approximately the average load on a proposed plant, the average price to be obtained for power or the average efficiency of the translating devices which will be used. So probable and natural a thing as competition from any cause, or adverse legislation, will totally change the conditions of economy.

For these reasons neither Kelvin's law nor any modification thereof is a safe general guide in determining the proper allowance for loss of energy in the line. Only in a few special cases is it conveniently applicable. Each plant has to be considered on its merits, and very various conditions are likely to determine the line loss in different cases. The commonest cases which arise are as follows, arranged in order of their frequency as occurring in American practice. Each case requires a somewhat different treatment in the matter of line loss, and the whole classification is the result not of *a priori* reasoning, but of the study of a very large number of concrete cases, embracing a wide range of circumstances and covering a large proportion of all the power transmission work that has been accomplished or proposed in this country.

Case I. General distribution of power and light from water power. This includes something like two-thirds of all the power transmission enterprises. The cases which have been investigated by the author have ranged from 100 to 10,000 hp, to be transmitted all the way from one to one hundred and fifty miles. The market for power and light is always rather uncertain, the proportion of power to light unknown within wide limits, and the total amount required only to be determined by future conditions. The average load defies even approximate estimation, and as a rule even when the general character of the market is most carefully investigated little certainty is gained.

For one without the gift of prophecy the attempt to figure the line for such a transmission by following any canonical rules for maximum economy is merely the wildest sort of guesswork. The safest process is as follows: Assume an amount of power to be transmitted which can certainly be disposed of. Figure the line for an assumed loss of energy at full load small enough to insure good and easy regulation, which determines the quality of the service, and hence, in large measure, its growth. Arrange both power station and line with reference to subsequent increase if needed. The exact line oss assumed is more a result of trained judgment than of formal calculation. It will be in general between 5 and 15 per cent., for which losses generators can be conveniently over-compounded. If raising and reducing transformers are used the losses of energy in them should be included in the estimate for total loss in the line. In this case the loss in the line proper should seldom exceed 10 per cent. A loss of less than 5 per cent. is seldom advisable.

It should not be forgotten that in an alternating circuit two small conductors are generally better than one large one, so that the labor of installation often will not be increased by waiting for developments before adding to the line. It very frequently happens, too, that it is very necessary to keep down the first cost of the installation, to lessen the financial burden during the early stages of a plant's development.

Case II. Delivery of a known amount of power from ample water power. This condition frequently arises in connection with manufacturing establishments. A water power is bought or leased *in toto* and the problem consists of transmitting sufficient power for the comparatively fixed needs of the works. The total amount is generally not large, seldom more than a few hundred horse-power. Under these circumstances the plant should be designed for minimum first cost, and any loss in the line is permissible that does not lower the efficiency enough to force the use of the next larger size of dynamo and water wheel. These sizes almost invariably are near enough together to involve no trouble in regulation if the line be thus designed. The operating expense becomes practically a fixed charge, so that the first cost only need be considered.

Such plants are increasingly common. A brief trial calculation will show at once the conditions of economy and the way to meet them.

Case III. Delivery of a known power from a closely limited source. This case resembles the last, except that there is a definite limit set for the losses in the system. Instead, then, of fixing a loss in the line based on regulation and first cost alone, the first necessity is to deliver the required power. This may call for a line more expensive than would be indicated by any of the formulæ for maximum economy, since it is far more important to avoid a supplementary steam plant entirely than to escape a considerable increase in cost of line. The data to be seriously considered are the cost of maintaining such a supplementary plant properly capitalized, and the price of the additional copper that will render it unnecessary. Maximum efficiency is here the governing factor. In cases where the motive power is rented or derived from steam, formulæ like Kelvin's may sometimes be convenient. Losses in the line will often be as low as 5 per cent., sometimes only 2 or 3.

Case IV. Distribution of power in known amount and units, with or without long distance transmission, with motive power, which, like steam or rented water power, costs a certain amount per horse-power. Here the desideratum is minimum cost per hp, and design for this purpose may be carried out with fair accuracy. Small line loss is generally desirable unless the system is complicated by a long transmission. Such problems usually or often appear as distributions only. Where electric motors are in competition with distribution by shafting, rope transmission and the like, 2 to 5 per cent. line loss may advantageously be used in a trial computation.

The problem of power transmission may arise in still other forms than those just mentioned. Those are, however, the commonest types, and are instanced to show how completely the point of view has to change when designing plants under various circumstances. The controlling element may be minimum first cost, maximum efficiency, minimum cost of transmission or combinations of any one of these, with locally fixed requirements as to one or more of the others, or as to special conditions quite apart from any of them.

In very many cases it is absolutely necessary to keep down the initial cost even at a considerable sacrifice in other respects. Or economy in a certain direction must be sought even at a considerable expense in some other direction. For these reasons no rigid system can be followed, and there is constant necessity for individual skill and judgment. It is no uncommon thing to find two plants for transmitting equal powers over the same distance under very similar conditions, which must, however, be installed on totally different plans in order to best meet the requirements.

(To be continued.)

Parabolic Electromagnetic Reflectors.

BY ALFRED G. DELL.

I made a pair of parabolic reflectors, which work fairly well. I can place the reflector, with its focus three or four feet from a piece of sheet zinc three feet by five feet, and the focus of the receiver seven or eight feet from the same, both being inclined to the zinc sheet at about the same angle, and obtain a fair spark at the spark-gap of the receivers. They do not work anything like as well as the vibrator and circles described in THE ELECTRICAL WORLD of Jan. 12, but well enough to show an angular deflection perfectly. When they are opposite and close to each other the spark in the receiver is very strong; the charge being so strong that if any part of the spark-gap is touched with the hand the physical effect is very perceptible. The following is a description of the construction:

I made the ends of four pieces of one-inch pine board, each 12 inches wide and 34 inches long. After drawing a parabola of five-inch focal distance on one piece, I laid the curve off into one-inch spaces, and with an awl bored holes, making the holes one inch apart along the curve; I then screwed this piece on another of the boards with the curve on the inside and marked every hole by pushing the awl through the holes already bored, and then, separating the pieces, bored the holes through where marked; this makes the sides for one of the pair, particular attention being paid to keeping the inside, when screwed together, on the inside when set up. The other one was worked in the same way, fastening the one having the curve to another board, and marking and boring the holes, and fastening that on to another board, and marking and boring the holes and keeping the inside on the inside when set up.

The hole at the focus in each board was also bored when fastened together. The holes are directly opposite each other on account of the way they were marked off and bored. I then, after sawing off the corners of the boards when fastened together with the screws in the same places where wire holes were marked, screwed on strips two feet long, and fastened copper wires (No. 16) from hole to hole, drawing them tight. In the focus of the one that received the current from the coil I placed two stiff brass wires (No. 16), each extending from the focus to the centre, of such a length that when through the sides there would be a space between the ends, which were rounded off. Around each wire and fastened to it I placed a brass cylinder three-quarters of an inch in diameter and four inches long, and surrounded each cylinder and wire running up to the side with a piece of sheet zinc bent into a cylinder one and a half inches in diameter, open on the back, through which opening the current is let into the arrangement from both sides of the spark-gap; the current wires are fastened to the brass wires and insulated from the zinc cylinders with pieces of gum tubing. It is the same principle as the plane vibrator arrangement. Nothing is seen when looking at the sparking arrangement but the zinc cylinder, spark-gap, and wires passing through the back of the parabolic reflector and through the pieces of gum. There is no current connection with the zinc cylinder.

The receiver arrangement is made of two pieces of straight brass wire one-eighth inch thick, one being fastened at each focus, leaving a space of one inch in the middle; from each wire, an insulated wire passes to the back of the receiver, and to a spark-gap placed in the most favorable position to see it. The spark-gap arrangement is made of a piece of oak, one inch square, with a wide slit sawed out; a piece of brass wire is fastened to each side and passes through a hole near the top of the slit and fine round points are filled opposite each other. A brass screw is arranged so the points can be separated, and also a bolt arranged so they can be tightened up. The spring of the wood will bring the points together by using the one screw; the other can be used to strengthen the spring of the wood. Connected with the spark-gap are two brass knobs three-fourths inch diameter, one on each side. A hole is drilled in each knob, and from each hole there hangs a loose copper wire ten inches long. In trying to get constant sparking, I found I could get only flashes, but that a wire held loosely to each knob would brighten and render steady the spark obtained. I tried screws with nuts, used so successfully with circles, but found they did not do well. I insulated all the connections about the spark-gap with sealing wax. The same battery and coil are used with circles as with the reflector.

Static Electricity and Printing.

To the Editor of The Electrical World:

Sir:—Referring to the recent discussion in THE ELECTRICAL WORLD in regard to the presence of static electricity in paper, we have in our paper mills been more or less troubled with it, as are all paper-makers. It occurs mostly as the paper leaves the calenders and at times the charge is heavy enough to produce a spark six or eight inches in length, which, it is needless to say, makes it very uncomfortable handling the paper. A steam damper, such as illustrated in the Jan. 26 issue of your paper, will obviate all this. On papers where we cannot use the damper we use a copper wire which touches the top of the sheet, or rather lies on the web of the paper as it passes from the calenders to the reels. This wire must be well grounded to produce good results. We have no trouble with the paper when it is cut into sheets.

FRANK L. STEVENS.

NORTH HOOSICK, N. Y.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 922 Chestnut street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English, French or German languages. It will be to the advantage of all concerned if editors of non-electrical journals, or of such electrical journals as are not regularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

Note.—As the present issue goes to press earlier than usual, the abstracting of some of the American journals will be postponed for one week.

DYNAMOS, MOTORS AND TRANSFORMERS.

Dynamos Without Commutators.—Mr. Mengen in "L'Eclairage Elec.," Jan. 19, criticises the article of Mr. Malagoli abstracted in the Digest, Feb. 9, stating that his deductions are not correct and that the current obtained will be alternating and not continuous. "L'Ind. Elec.," Jan. 25, also criticises the article very severely, stating that this would upset the fundamental laws of induction and that his calculations are entirely incorrect.

Calculation of Multiphase Motors.—The concluding portion of the article by Mr. Cahan is published in the "Elek. Zeit.," Jan. 31. Mr. Legrand's article is contained at great length in "L'Eclairage Elec.," Jan. 19, including a large number of characteristics.

First Polyphase Motor.—In the Lond. "Elec.," Feb. 1, Mr. Giorgi states that the priority of invention of the rotary field motor is due to Pacinotti, who, in 1873, advanced a similar and more perfect arrangement than that proposed by Mr. Baily (see Digest, Feb. 2 and 9); it consists of a fixed ring-wound armature divided into sections and connected with the bars of a commutator in the usual way; a pair of brushes was moved around the commutator producing a rotating field; it was intended for transmitting signals in a quadrant telegraph; the continuous rotation of a magnetic field obtained by means of alternating currents, however, was discovered by Prof. Ferraris. In reply to this Dr. Thompson states that it lacks the essential feature, namely, the driving by induced currents; in its production of a revolving field it was anticipated by several, as by Wheatstone about 1849; Baily not having alternating currents in quadrature imitated them artificially by a commutator.

Direct Connected Dynamos.—"Cassier's Mag." for February contains an article by Mr. Smith, in which he describes and illustrates quite a number of direct engines and dynamos, including also the Willans engine (England). He also discusses at some length the relative advantages of direct vs. indirect connection.

LIGHTS AND LIGHTING.

The Electric Arc.—Mrs. Aryton's paper (see Digest, last week) is continued in the Lond. "Elec.," Feb. 1. Regarding the discrepancy between the results which she gave and the statement of Dr. Thompson, it is stated that he meant that the area and not the diameter of the crater was proportional to the current, the discrepancy is, therefore, not as great; she intends to measure the true areas of the craters more accurately to see how far this is correct; a table is given containing the measured and calculated diameters, which show that for all currents between a comparatively small one and the largest that will give a silent arc, the diameter of the crater may be expressed with surprising accuracy as a linear function of the current (containing a constant term). All the curves connecting the voltage with the length of the silent arc for various currents close up into a single curve for hissing arcs. It is shown at some length, including examples, how the curves may be employed to calculate the resistance of the extra resistance used with an arc lamp (when run in multiple arc) and the voltage which will produce a silent arc of given length with a given current; the curves also show that such resistances, besides preventing too great a current, perform the very important function of making it possible for a solenoid to regulate the length of the arc.

Incandescent Lamp Tests.—A Physical Society paper by Prof. Ayrton and Mr. Medley is abstracted briefly in the Lond. "Elec. Rev.," Feb. 1. They found that with the newer lamps tested, the candle-power, current and candles per watt, all rose as the lives increased; they satisfied themselves that this surprising result was correct; the Edison-Swan lamps showed hardly any blackening even after 1,300 hours; the candle-power was always accompanied by a rising current which, however, was proportionally much smaller, so that the consumption of power was less after 50 hours than at the beginning; the 100-volt lamp of this make required 4.3 watts per candle; the maximum increase of light recorded was 45 per cent.; with lamps of the type examined there is no point at which it becomes economical to discard a lamp before its filament breaks; no marked economy can be gained by overrunning such lamps. Prof. Ayrton first attributed this improvement to a better vacuum, the more a lamp was used the better the vacuum became; but he found later that although the improvement in the vacuum was equally marked, the increase in candle-power varied between very wide elements, being very considerable in some and hardly perceptible in others; the lamps in the tests were kept running during the night and discontinued during the day.

Electric Light Photography.—Mr. Swan, in the Lond. "Elec. Rev.," Feb. 1, points out the advantages of the incandescent light which, although less rich in violet rays than the arc light, is much better as the color misrepresentation, which is so marked when the arc light is used, is rectified to a considerable extent.

The Electric Arc.—An abstract, including some of the illustrations, of the paper by Mrs. Ayrton (see above) is published in the "Elec. Eng.," Feb. 13.

Arc Lighting.—A brief abstract of Prof. S. P. Thompson's second lecture, mentioned above, is reprinted in "El'ty," Feb. 6.

Fredureau Diffusing Globes.—The translation in abstract of a French Academy paper by Prof. Potier, describing these globes, is published in the "Elec. Rev.," Feb. 6. (These globes were described and references given to very complete descriptions in the Digest, 1893, March 25, May 27, Dec. 2, and 1894, Feb. 10; a very similar globe was described Nov. 10, see also Dec. 1, 1894, and Jan. 5, 1895.)

Welsbach Light.—The recent editorial in the Lond. "Elec. Rev." (see Digest, Feb. 9) on the report of the Lancet Commission is reprinted in "El'ty," Feb. 13.

POWER AND HEAT.

Large Three-Phase Plant.—"Cassier's Mag." for February contains a well illustrated article by Dr. Bell on "Electricity in Textile Manufacturing," in which he describes the three-phase plant installed at the works of the Columbian Cotton Company, South Carolina, which has now been running over eight months; it is said to be the largest multiphase plant now in operation and the first sweeping application of the motor for driving machinery for textile manufacturing. Two generators of 500 kw are each connected to horizontal turbines, besides being coupled together with a positive coupling so that they can be run in parallel; the weight of each armature is about 16 tons and that of the complete machine 50 tons; the armature is 10 ft. in diameter, the voltage 575 and the frequency 36; there are 20 induction motors of 65 hp each arranged to be secured to the ceiling; the specification required that the change of speed should not exceed 3 per cent. between friction load and full load; the greatest variation was found to be from 2.2 per cent. down to 1.5 per cent in the different motors; the speed of the motors is 535; a starting resistance is placed within the armature spider and cut out by a long level which slides a ring along the shaft until it short-circuits the resistance; each motor drives short, light shafts; the net efficiency of the whole system from the shaft of the generator to the shaft of the motor is not less than 82 per cent. The wires from the power house to the factory are underground, the system used being illustrated and described; it consists of a heavy wooden conduit 12 inches square, coated inside and outside with pitch and having about every 3 ft. a crib work of insulated conduit tubeing through which pass similar conduit tubes in which the cables are laid, the whole conduit being then filled solid with pitch; where the lines cross a bridge the conduit is sealed with sulphur for about 2 ft. and the separate tubes are then carried across insulators on an iron structure; "it would be most extraordinary if there should be any signs of leakage or a short circuit in a structure so constituted."

Folsom-Sacramento Transmission—The "Elec. Eng.," Feb. 13, contains a description by Mr. Guy of this projected plant; it is said to be second only to the Niagara plant in magnitude and of equal interest in many respects; 5,000 hp of water power obtained by means of a dam across the American River near Folsom, will soon be available; the electrical data is given only very briefly; there will be four three-phase generators

of 1,000 hp each coupled directly to the shafts of the water wheels; these generators weigh 40 tons each and are the largest ever built except those for the Niagara Falls plant; the current will be transformed up to 10,000 volts at which it will be transmitted to Sacramento, a distance of about 24 miles on six bare, hard drawn No. 0 wires; 1,000 hp will thus be transmitted to Sacremento.

Power Transmission in Sweden.—Some data regarding the very large proposed plant described in the Digest, Aug. 4, is given briefly in the "Elec. Eng.," Feb. 6 (more complete data will be found in the Lond. "Elec.," July 13, the reference given in the Digest).

Electric Plow.—A brief description of the one described in the Digest, Dec. 15, is given in the "Elec. Rev.," Feb. 6.

Rolling Lift Bridge.—The motors of the new bridge in Chicago, which is operated electrically with 200 hp, are described and illustrated with some good illustrations in the "West. El.," Feb. 9.

Electric Fire Engine.—In an article by Mr. Sachs, in "Cassier's Mag." for February, he gives a brief descriptive history of the fire engine; the latter part is devoted to electric fire engines. Stationary electric fire pumps are to-day used in many establishments; he describes several portable forms; those using storage batteries will not be practical until the storage battery is made lighter, stronger and more efficient than it is to-day; he mentions one made in England in which the current was to be supplied through underground feeders connected to boxes at regular intervals; another devised by Mr. Wheeler gave very good results and is now used at a factory in Ampere; the city of Lynn, Mass., is to have an electric fire engine; electric fire engines would be efficient and thoroughly practical were the question of current supply settled and if the outlay were not so great; he thinks a separate system of mains for this purpose would be best. (Why not use the trolley wire current, and pay for it by meter; it exists on most streets in many cities; the cars are usually stopped during fires and the extra load would therefore not be felt.)

TRACTION.

Traction.—The complete Institution papers by Messrs. Wilkinson, Blackwell, Dawson and Preller, all of which have been abstracted in the Digest recently, are published in full with the illustrations and the discussion, in the "Jour. of the Institution of Electrical Engineers" for January. References to a number of American reprints of some of these papers have been given in the Digest.

Electric Traction.—In a continuation of Mr. Dawson's serial in Lond. "Engineering," Feb. 1, he gives, among other things, the conclusion of the table of electric lines in Europe, which table includes columns of data for each line; the operating expenses of some of the lines are also given.

Light Railways.—The report of the committee of conference of the Board of Trade is published in the Lond. "Elec.," Feb. 1.

Electric Cable Railways.—A well illustrated article by Mr. Preller is begun in Lond. "Engineering," Feb. 1; he shows the advantages of operating cable mountain railways by electric power, transmitted to the upper end from a distance and over the older systems of loading the descending car with water; he gives a well illustrated description with data of the Bürgenstock mountain line in Switzerland.

Accumulator Line in Hagen.—A translation of an abstract of the article by Mr. Feldmann, abstracted in the Digest Feb. 9, is published in the Lond. "Elec.," Feb. 1.

Accumulator Cars in Vienna.—The regular running of a portion of the lines began Jan. 15; the Waddell-Entz copper-zinc accumulators are used.

Electric Carriage.—The data regarding the Tommasi accumulators used on an electric carriage in Paris is given in the Lond. "Elec. Rev.," Feb. 1.

Trolley System Applied to Steam Roads.—The "Elec. Eng.," Feb. 13, gives the views of several authorities on how it shall be applied. Mr. Leonard believes in electrical locomotives rather than motor cars; he does not believe in the use of the three-wire system for railways; he thinks that the E. M. F. should not be less than 200 volts per mile of transmission of the power; he thinks it should be transmitted as an alternating current reduced before reaching the trolley wire and transformed on the locomotives into a continuous current. Prof. Elihu Thomson believes that it should be begun by placing motor cars on the tracks where it is desirable to do so, taking the current from an overhead wire; this would not interfere with the use of the ordinary locomotives for the hauling of the usual trains; such lines might traverse only a portion of the existing road with branches for the electric cars to more or less remote points; in this way the advantages of the trolley might be used to form feeders which "may for some time to come preserve the character of a steam line." If a long train is to be drawn it may be well to use locomotives, particularly if the grades are not great, or, perhaps, a compromise in having one or more extra heavy motor cars at the head of a train of trailer cars; 1,000 volts would be feasible; the overhead system would be the best except on elevated roads; the three-wire system would not necessarily be applicable in all cases, but would probably be desirable for certain types of double track roads. For heavy work over long distances it is probable that transforming systems must be used at 5,000 to 10,000 volts, transformed by machines, to sections of the trolley line or low pressure feeders; it may be possible to use alternating current motors of low potential carried directly on the driving axles, particularly where high speeds are attained; means are now in existence for controlling the speed and obtaining variations of speed with high economy where several such motors are employed to drive a train. Messrs. Houston and Kennelly prefer motor cars to locomotives, as it enables more cars to be run at more frequent intervals, to which factor, as much as any other, the popularity of the trolley system is due; they recommend 1,000 volts and the three-wire system, which may afterwards be raised to 2,000 without any change in the line construction; they recommend the overhead wire and single trolley; they recommend following the present system of trolley roads rather than attempting radical innovations.

Supplementary Wire.—In the "Elec. Eng.," Feb. 13, Mr. Henry criticizes the recent statements of Mr. Wynkoop (see Digest, Jan. 26). The most important object of this wire is to insure a metallic return around defective rail joints, should any occur; he believes that to do without it opens thousands of chances for failure which do not exist at present. There are numerous solutions to the railway problem referred to; regarding the double trolley wire system he believes "if a few of the modern roads were to adopt it the others would follow like a flock of sheep." If the track rails are used the supplementary wire should be a well insulated one, and where the copper is exposed it should be carefully painted with paraffin paint; it should contain switches at intervals for the insertion of an ammeter, so that the current in it can be measured as an indication of the condition of the rail joints; by simultaneous readings at different points defective joints can be located with ease and certainty.

Power Consumed on Electric Railways.—A translation of a part of the article by Mr. Pellissier, mentioned in the Digest, Dec. 8 and 25, is published with some of the tables, in the "St. Ry. Jour." for February.

Brooklyn.—The power house of the Nassau Company is described and illustrated in the "St. Ry. Gaz.," Feb. 9.

Low Rail Joints and their Prevention.—An article by Mr. Amstutz on this subject is published in "El'ty," Feb. 13.

Electric Carriage.—The one described in the Digest, Feb. 16, is illustrated in the "West. El.," Feb. 9.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Single-phase vs. Multiphase Systems.—A long paper by Mr. Goerges on a comparison of the two systems from an industrial standpoint is reprinted in the "Elek. Zeit.," Jan. 17. He enumerates the various systems but limits himself to a comparison between the single and the multiphase, and under the latter, between the three-phase and the two-phase systems; he compares them with regard to the first cost and cost of operation on the one hand and the simplicity and application on the other. Theoretically the multiphase system is the best, chiefly for the reason that the heat generated for the same amount of wire is considerably less, the currents should therefore be combined as much as possible, which is done best by the three-phase system. In the generators and motors it may be said that other things being equal, the armature reaction and the dispersions of the lines of force may be said to be proportional to the current strength; for an equal amount of energy the currents for the single, double and three-phase systems are as 100 to 50 to 57.8. If the armature contains an iron core without pole projection, it has been shown repeatedly that the materials are used more economically in the multiphase than in the single-phase system, which he discusses by numerical examples; when the armature has pole projections the multiphase machines also give a considerably greater output. At the switchboards the multiphase currents required somewhat more expensive apparatus, but this is hardly of any importance. Regarding the weight of the leads for an equal output, drop and voltage the figures are as follows: for single-phase, two wires 100, three wires (the neutral wire being one-half that of the others) 31.35; for two-phase currents, four wires 100, three wires 72.8; for three-phase currents, three wires 75, four wires 29.2, the latter system being somewhat troublesome, especially when cables are used; these figures apply to the low tension circuits, in which the voltage is no criterion, but for the high tension system the voltage must be considered; with the two-phase system, with three wires the voltage between the lines which are not combined is 1.41 times as great as the working voltage; reducing the voltage to the same amount the weights are as follows: Single-phase, two wires 100; three-phase, three wires 75; two-phase, four wires 100, three wires 145.5. The construction of the lines is more expensive for multiphase currents; the transformers when small are in favor of the single-phase current, but when large the costs will be about the same; for the two-phase system they will be more expensive than for the three-phase. Considering everything, the calculations for numerous projected plants show that when there is a secondary circuit the three-phase current with three wires is cheaper than the single-phase current with two wires and somewhat more expensive than the single-phase current with three wires. He discusses at considerable length the subject of motors, including a discussion of the torque and heat in the armature; in practice it is found that a single-phase motor has about 70 per cent. of the output of a multiphase motor of the same price and weight, and at the same time an efficiency 6 to 10 per cent. less, besides this the range of the high efficiency is not so great; as regards cost, the multiphase motors, es-

pecially the smaller ones, have the advantage. He discusses whether the multiphase system has any inherent objections; it has been stated frequently that it is not possible to keep the voltage in the three-phase system constant when the branches are unequally loaded and that complicated apparatus is required for regulating this; he states that this is only a question of the construction of the machine, all objections being completely overcome in the machines by having a small armature reaction; motors on the three-phase circuits exercise a regulating action; with greatly unequal loads a motor will even supply energy to one of the circuits; besides this they reduce the percentage drop. The attendance in a three-phase station is the smallest possible and no separate regulation of the three branches is required; two-phase currents can be regulated independently only when each machine contains two separate armatures, which makes them much more expensive. Same modifications have been suggested; in the railway station installation at Dresden the three-phase machines are connected for the star winding, but the lamps are all connected to only one pair, the third wire being used only for motors; in another system the third wire is used only for starting the motors, but this he considers not as good, for if the wire is laid, why not use it continuously? He summarizes his conclusions as follows: The three-phase system is better from a commercial standpoint, especially for greater distances, the regulation offers no difficulties, multiphase motors are cheaper, more economical, more convenient and cause less irregularities in the light. In the discussion Mr. Roos called attention to the fact that Mr. v. Dobrowolsky showed a number of years ago that three-phase transformers act to a certain extent as regulators for the three circuits. Mr. Kapp differed in a number of points; he believes that Mr. Goerges did not attribute to the three-phase motor all the good properties which it possesses; for motors of equal weight, if those of two-phase currents give say 100 hp, those for three-phase currents will give 111 hp; he differs regarding the cost of single and three-phase ransformers; one three-phase transformer for a 100 hp surely does not cost more than three single-phase transformers of 33 each. He believes that to make the armature reaction small in order to improve the regulation is somewhat dangerous, as a certain amount of reaction is an advantage because the machine will not suffer so much by short circuiting; a practical machine should not give more than three or four times the normal current when it is short circuited, and in that case it must have an appreciable loss of energy, the proper choice therefore is in the nature of a compromise which he believes is more unfavorable for the star connection than for the triangle connection. In reply Mr. Goerges stated that in Chemnitz (see Digest, last week) the machines have a drop of 7 per cent. at constant excitation and with an inductionless external resistance, and when short circuited they gave three times their normal current; when driving motors the drop may be four times as great; he believes that the differences between the two ways of connecting the circuits are quite small, both methods being used; in the triangle connection, if the current is not of the sine form then there may be a circulation of current, thereby increasing the heat; he believes that it would be much better to adopt one kind, and for this he prefers the star connection; in Chemnitz the triangular connection has been adopted, which is better when cables are used, as they then require only three wires; when the star connection is used the neutral wire need not be brought back to the machine, but only back to an equalizer consising of a transformer; in this case the results are very good, when 100 lamps were inserted in one branch, 20 in the other, and 1 in the third there was no noticeable difference in the voltage.

Capital Invested in Central Stations.—The Lond. "Elec.," Feb. 1, publishes a list of the central stations in Great Britain, giving the capital invested in each one; the total capital actually expended is as follows: By companies about $9,600,000, and by local authorities $26,200,000.

Central Station Statistics for France.—"L'Ind. Elec.," Jan. 25, publishes its annual table in the form of a supplement; it is like those published by that journal near the beginning of each year, and is undoubtedly the most complete of its kind published for France; no general deductions or details are given.

Continental Stations.—A report by Mr. Metzger containing brief descriptions and comments on some stations in Germany is published in the Lond. "Elec.," Feb. 1.

England.—A description accompanied by a number of illustrations of the stations at Halifax, Nottingham and Dewsbury are given in the Lond. "Elec. Rev.," Feb. 1.

Amsterdam.—A description of this station is published in Lond. "Engineering," Feb. 1; the load diagrams for each of the first six months of the year are given; the maximums of all are nearly alike, and they nearly coincide from the maximum down, but differ greatly in the rise from the minimum up.

WIRES, WIRING AND CONDUITS.

Explosions in Conduits.—The Lond. "Elec.," Feb. 1, states that mere ventilation of the conduits may or may not afford adequate protection; it suggests using covers made of wrought iron in the form of a gridiron, so as to afford no obstacle to the air in case of an explosion; there would have to be a plate some distance below to catch the rain and dirt leading it to a suitable trough.

The subject is discussed by Mr. Jenkinson in the Lond. "Elec. Rev.," Feb. 1; he thinks it ridiculous to condemn bare copper as was done recently; it is not necessary to have a short circuit to cause a spark, as a slight leak is quite sufficient; he believes there would be little difficulty in properly draining and ventilating existing conduits; he suggests finding the lowest points and then building drain pits there.

Another installment of the opinions of central station managers is given in the Lond. "Elec. Rev.," Feb. 1.

Conduits.—An illustrated description of the conduits and subways of the Nottingham station is given in the Lond. "Elec. Rev.," Feb. 1; it is said that this is the first town in that country where any attempt has been made on a fairly large scale to use subways for the mains.

Underground Wires in Paris.—The article of Mr. Monmerque (see Digest, Jan. 26) is continued in "L'Eclairage Elec.," Jan. 19.

Telephone Cables with Dry Air Circulations.—The "Jour. of the Institution of Electrical Engineers," for January, abstracts at some length an article by Mr. Barbaret, from the "Ann. Telegraphiques," Vol. 21, May-June. He describes the Fortin-Hermann cables in which paraffined wooden beads are strung on the wires which are then incased in a lead pipe; he describes the case, apparently the same as that referred to in the Digest, Jan. 26, in which a leak in one of the cables was repaired completely by circulating dry air through the cable; he describes this process, which is now used frequently; the apparatus is also described.

Cable Connections.—A new method for which a number of advantages are claimed is described and illustrated by Mr. Feussner, in the "Elek. Zeit.," Jan. 31, in the form of a contribution from the Imperial Reichsanstalt. A ferule is placed around the strands and a conical wedge is then driven between them; the ends are then filed off and soldered as a butt joint; a method of connecting the cable to a flat terminal having a hole through the centre is also shown; the cable is flattened and inserted in a slot, after which it is soldered.

ELECTRO-PHYSICS AND MAGNETISM.

Mirrors of Magnetism.—The recent Physical Society paper, by Prof. S. P. Thompson and Mr. Walker, is published in full with illustrations in the "Phil. Mag.," for February. Reprints of the paper were referred to in the Digest, Dec. 22 and Jan. 11; the phenomenon on which it is based was described in the Digest, March 24, 1894. If a coil carrying a current is placed with its end against a large plate of iron a field is obtained on one side of the plate, of the same shape, as if the coil were continued to double its length, that is, there is a magnetic image produced analogous to the optical image produced by a mirror; this refers only to the space in front of the iron plate, as there is no effect behind it. A number of interesting experiments are described, as for instance, removing the coil slightly from the iron or placing it in an inclined position, and in each the effect was analogous to that in optics; there is one difference, if the pole toward the plate is a north pole, for instance, the magnetic image has its south end pointing towards this pole. They consider the possibility of a magnetic kaleidoscope, also the effects of curved plates which are discussed mathematically, applying the formulas relating to electric images.

Values of Magnetic Quantities.—In "L'Ind. Elec.," Jan. 25, Mr. Culmann publishes a large table covering two full pages containing the values of the intensity, the induction, the susceptibility and the permeability, for each of about 500 gradually increasing values of the magnetizing force; they are based on the recent experiments of Roessler, and refer to a very soft, well annealed wrought iron. (It is of use for that particular quality of iron only; it is a question whether such great accuracy is warranted by the data on which it is based.)

Change of Length in Soft Iron Wire in a Magnetic Field.—In a brief communication by Mr. Rosing in the "Phil. Mag." for February, he gives some results which agree in general with those of Mr. Nagaoka published in the "Phil. Mag.," No. 224.

Earth's Magnetism.—An Academy paper by Mr. Moureaux, giving the constants for the first of the year near Paris, is reprinted in "L'Ind. Elec.," Jan. 25, and "L'Elec.," Feb. 2.

Propagation of Electric and Magnetic Perturbations.—Mr. Boudin's article is continued at some length in "L'Eclairage Elec.," Jan. 19.

High Frequency Experiments.—A description of the experiments of Dr. Toepler with large influence machines (see Digest, Dec. 29 and Jan. 12) is published in the Lond. "Elec. Rev.," Feb. 1.

Thermo-Electric Power of Electrolytes.—The paper by Mr. Lussana, from the Italian, is abstracted briefly in the "L'Eclairage Elec.," Jan. 19.

New Constituent of the Atmosphere.—An interesting abstract of the recent Royal Society paper by Lord Rayleigh and Prof. Ramsay, concerning the new element argon is given in the Lond. "Elec.," Feb. 1.

Electrodes Sensitive to Light.—The "Elec. Eng.," Feb. 6, abstracts briefly the paper by Mr. Luggin, which was abstracted in the Digest Dec. 15.

Spectrum of Discharge in Liquid Oxygen, Air and Nitrogen.—The "Elec. Eng.," Feb. 6, abstracts briefly from the paper in the "Phil. Mag." for August, by Profs. Liveing and Dewar, which was mentioned in the Digest, Sept. 15.

Modern Theories of Electricity.—The discussion of Prof. Rowland's recent article (see Digest, Jan. 12) by Prof. Lodge, which was abstracted in the Digest, Feb. 9, is reprinted in full in "El'ty," Feb. 6, and discussed editorially. It is reprinted also in the "West. El.," Feb. 9.

Electromagnetic Oscillations.—The recent editorial from the Lond. "Elec. Rev.," mentioned in the Digest, Feb. 16, is reprinted in "El'ty," Feb. 13, and is discussed in an editorial in which attention is called to some investigations of Mr. Perry, in which almost identical results are said to have been obtained.

Transparency of Metallic Films to Cathode Rays.—An article from the Baltimore *Sun* describing briefly Mr. Lenard's recent discovery, which it is claimed is the most striking original work which was done during the past year, is reprinted in "El'ty," Feb. 6. (A description of these experiments was given in the Digest, April 14; references to other articles on Lenard's discovery were given March 24, April 21, May 19, June 16 and 30, July 21, Sept. 15, Nov. 24 and Dec. 22.)

Magnetic Mechanism. –The first part of an article by Prof. Stine on this subject is published in the "Elec. Age," Feb. 9; in the present portion he describes the nature of theory of magnetism with the aid of some novel and interesting diagrams.

Future of Electricity.—Mr. Walker's article, mentioned in the Digest, Jan. 26, is reprinted in "El'ty," Feb. 13.

ELECTRO-CHEMISTRY AND BATTERIES.

Borchers' Battery.—The Lond. "Elec.," Feb. 1, contains a communication by Messrs. Barnes and Veesemeyer, in which they give the results of some investigations on the lines indicated by Dr. Borchers (see Digest, Feb. 9 and 16, under Electricity Direct from Coal, where further references are given), which, however, differ widely from those he obtained; copper and carbon were used; the results are given in a table which, however, is not very clear; but whether the figures given stand for the voltage, current, or are only relative, they show that without air they are very low, with coal gas and air somewhat higher, but highest of all with air alone; a hydrochloric acid solution gave better results than one in ammonia or sodium chloride. The voltages were greatly influenced by the velocity of the admitted gases and more especially by the unavoidable process of the oxidation of the solution; it was impossible to prevent this rapid oxidation from spoiling the remaining solution; the copper plate was invariably attacked and various salts formed; no carbon dioxide whatsoever could be detected in the escaping gases from any of the elements nor was any carbonate found in the ammoniacal solution. "In defence of Dr. Borchers it must be said that the poor results obtained when both electrodes are of carbon are not decisive, as the action of copper might possibly fall under the head of a phenomenon similar to catalysis, and play an important part without a loss of weight in the plates. However, the above results point most decidedly to oxygen and copper as sole current generators, and if Dr. Borchers remains silent much longer it will seem as if he, too, had been forced to give up the ideas originally advanced."

Local Action in Accumulators.—In the Lond. "Elec. Rev.," Feb. 1, Mr. Epstein gives the results of a test in which it was found that the loss of a charge during about three months' rest amounted to only 20 per cent.

Zincing Process.—The Lond. "Elec. Rev.," Feb. 1, publishes some large illustrations accompanied by a brief description of several installations in which the Cowper-Coles electro-zincing process is used, in one of which the capacity of the tanks is 14,000 gallons; one of the interesting features is that the bath is kept up to its proper strength by means of finely divided zinc kept in suspension in the electrolyte.

Purification of Acetic Acid.—The "Zeit. f. Elek." Jan. 15, abstracts some statements from a Russian electrical journal concerning a process of Mr. Eremin for purifying it electrically; the process is not described as it is about being patented, but it is stated that it has been in use for several years and is so satisfactory, cheap and rapid, that it has replaced the usual distillation apparatus, which cannot compete with it; an objection to the older process was that some of the acetate of copper was also distilled, while in the present process it is removed.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measurement of Resistance.—In an article by Mr. Schuster, published in the "Phil. Mag." for February, he discusses the question of the limit of accuracy of the measurement of resistances; the sensitiveness is always increased by increasing the E. M. F., but the heating of the conductors puts a limit to it; he discusses the question mathematically and arrives at the following conclusions: "With a given resistance and galvanometer the ratio of the smallest change of resistance which can be detected to the sum of the given and galvanometer resistance is equal to the ratio of the smallest current which can be detected by the galvanometer to the maximum current which can be sent through the resistances." "With a given conductor and type of galvanometer, the smallest change per unit-resistance which can be measured is given by twice the ratio of the smallest current which can be detected by means of a galvanometer having the same resistance as the one to be measured to the greatest current which can be sent through the galvanometer." "The highest percentage accuracy with which a given resistance can be measured is directly proportional to the square root of the maximum electric work which can be done on it without overheating." From a table of factors he shows that if, for instance, the galvanometer resistance is 5 times too great or too small the sensitiveness is reduced 25 per cent.; he thinks sufficient consideration is not usually paid to the proper choice of the galvanometer resistance; he recommends using galvanometers with a number of coils which can be variously connected; with three galvanometers each having four coils respectively of 0,01, four and 1,000 ohms, resistances could be measured varying between 0.0005 and 20,000 ohms, being always within 25 per cent. of the greatest obtainable sensitiveness as far as the galvanometer is concerned; if there is only one galvanometer a useful combination is obtained by choosing one of four coils of about 10 ohms each for measuring between 0.5 and 200 ohms with considerable accuracy. He discusses how closely the theoretical value may be approximated by each of the known methods, and concludes that there is really no theoretical advantage of the Wheatstone bridge over any other balance method, as he obtains for all of them the same limiting value; he believes that for very accurate measurements the differential galvanometer deserves more attention than it has so far received. In referring to platinum thermometers he shows that if small differences of temperature are to be detected there would be an appreciable advantage in substituting steel wire for platinum, but there are obvious disadvantages which in most cases would counterbalance the greater sensibility.

Student's Apparatus for Determining the Mechanical Equivalent of Heat.—The recent Physical Society paper by Prof. Ayrton and Mr. Haycraft is reprinted in full in the "Phil. Mag." for February; the illustration shows the complete apparatus; the paper was abstracted in the Digest, Jan. 12. In conclusion they give a recent history of the practical electrical units.

Determining the Electromagnetic Capacity of a Condenser.—The Physical Society paper by Mr. Womack, mentioned in the Digest, Dec. 22, is reprinted in full in the "Phil. Mag." for February; the method used is a modification of the ballistic galvanometer method.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone System Without a Central Station.—A system which has been in use in Prague for a number of years intended apparently for domestic telegraphy, is described in the "Zeit. f. Elek.," Jan. 15.

Origin and Development of the Telephone Switchboard.—A reprint of Mr. Kingsbury's Institution paper is begun in the Lond. "Elec.," Feb. 1, and "Elec. Rev.," Feb. 1, the latter containing a number of illustrations.

Vienna Telephone Installation.—A brief description without illustrations is published in the "Elec. Tech.," Jan. 15.

Telephonic Disturbances.—A paper by Mr. Pierard abstracted in the Digest, Feb. 9, is reprinted in abstract in "L'Eclairage Elec.," Jan. 19.

MISCELLANEOUS.

Educational.—The Lond. "Elec.," Feb. 1, contains a communication by Dr. Fleming on this subject (see Digest last week); it is clear and to the point. The student has to make a departure from some accepted facts in every piece of experimenal work and if he must calibrate his home-made ammeter with a copper voltameter you have to let him assume the received electro-chemical equivalent of copper; the question of the point from which he is to be started must be determined by what he is supposed to be able to do, that is, whether his goal is to teach physical science or to become a practical electrician; as the chief object of their education is to enable them to earn a living, the best system is the one which teaches certain things as an art, and afterward if he has time consider them as a science; his experience is that students take more interest in their work when they know they are working with the real thing and can get good quantitative results; much educational work would be far better conducted if the abstract were approached through the concrete, than vice versa; the character of the teaching must be to a large extent determined by the end in view.

Electric Siren.—A new form recently shown at the French Physical Society is briefly described in "L'Ind. Elec.," Jan. 25, and "L'Elec.," Feb. 2; the perforations are perpendicular to the plate and the rotation is produced by an electric motor; a number of important advantages are claimed; the pitch and the intensity are then independent, a low intense note or a sharp high pitched note can then be produced.

Electric Anemometer.—An Academy paper by Mr. Richard describing a new instrument is abstracted briefly in "L'Ind. Elec.," Jan. 25, and "L'Elec." Feb. 2.

Electric Log.—A translation of part of the article mentioned in the Digest, Feb. 2, describing the Fleuriais log, is given with illustrations in the Lond. "Elec.," Feb. 1.

Abstracts.—The "Jour. of the Institution of Electrical Engineers" for January contains a large number of abstracts of recent papers on electrical subjects, all of which have been noticed in the Digest, although in most cases more briefly.

Electrical Education.—In the "Elec. Eng.," Feb. 13, Prof. Kidwell discussed at considerable length the recent paper of Prof. Stine, with whose views he differs.

Biographical.—Some reminiscences of the late Rudolph Eickemeyer are given by Mr. Lain in the "Elec. Eng.," Feb. 13.

New Books.

American Electric Street Railways. Their Construction and Equipment. By Killingworth Hedges. London: E. & F. N. Spon. 201 pages, 201 illustrations. Price, $4.50.

The author of this work is a prominent English electrical engineer who recently made an extended tour through this country and Canada, and gives in the volume before us the result of his observations in the

field of electric traction. While the American electrical engineer may find but very little material in this volume with which he is not more or less familiar, it will certainly be a revelation to Europeans who are but slightly acquainted with the practical development of the electric street railway in this country.

Mr. Hedges has certainly gathered a vast amount of information on the subject, and while the book is merely a compilation of various material descriptive of practical results obtained, and apparatus employed, in American electric street railways, it has a distinctive value even to those who are familiar with American practice. Not considering it necessary to dwell upon the electrical principles, the author, after two very short chapters, takes up the roadbed, giving several of the more promising methods of track instruction, rail bonding, etc.; following are descriptions and illustrations of various plans of current distribution and supply, including the apparatus and methods employed in overhead construction. Several conduit systems which have been tried are described, but nothing is said about the many trials in this country of storage battery traction. Quite an extended account is given of the Siemens & Halske Budapest road. Succeeding are several chapters on the construction and equipment of cars, showing and describing different forms of trucks, motors, controllers and accessories, with discussions of the advantages of different motors, methods of control and gearing. Generators, boilers, engines and power house equipment follow, with descriptions of several important American electric street railways, among which are the West End and Niagara Falls roads; very few instances, however, of the most recent construction, using direct connected power units, are shown. Chapters on the comparative cost of traction by cable, electricity and animal power, on English electric tramways, on commercial considerations, Board of Trade rules and various formulæ and definitions, form the remaining material.

Many interesting and useful tables, curves and illustrations are included in the work, among which are some tables on the cost of steam and electric plant, arranged by Dr. Emery and Messrs. Crosby and Bell. Various data are also given relating to the cost and operation of electric street railways and a large number of diagrams and illustrations, most of which, however, are taken from various catalogues and periodicals. The author notes the fact that in most of the early stations "the old-fashioned belt or more modern rope-driven arrangements are still in vogue instead of the direct coupled engines and generators which are the rule in almost all the larger European central stations." As this is, however, not the case in the more recent stations, the author should also have stated that we have profited by our experience. Another point to be noted is the cost of operating the English tramways which, from the data given, is somewhat below American figures.

While the book, as a whole, is fairly complete, various recent features of the American electric street railway are omitted, but as a general description of the apparatus now in use the book serves its purpose. Although it contains no new or original matter the compilation describing the various machinery and appliances used in the construction and operation of the American electric street railway and the various data relative thereto, make it a most useful book to those who are not thoroughly familiar with the art, and the American electric railway engineer will also find many interesting and valuable tables embodied therein. Mechanically and typographically the book is excellent.

THE LIFE AND INVENTIONS OF THOMAS ALVA EDISON. By W. K. L. Dickson and Antonia Dickson. Boston: T. Y. Crowell & Co. 362 pages, 158 illustrations. Price $4.50.

A great deal of the material embodied in this book had previously appeared in a series of articles by the same authors in *Cassier's* and the *Century Magazine*, and with many additions and elaborations now forms a volume whose mechanical and typographical execution is worthy of the highest praise. The same, however, can hardly be said of the text, whether considered from a scientific, technical, or even literary point of view. The book is written in what might be called an exaggerated popular style, abounding with the most enthusiastic expressions of praise and admiration for the subject, and containing numerous passages of flowery rhetoric rather out of place in unfolding the biography of a great inventor. The authors appear to be entirely carried away with their subject, having but one thought—Edison—and they put forth, with every possible verbal decoration their utmost efforts to induce the reader to join them in their conclusion—that Edison is "the greatest genius of this or any other age."

In the first part of the work we are made acquainted with the early life and unconventional experiences of Mr. Edison, many new and interesting incidents and anecdotes being recounted; although we are more or less familiar with a great deal of the matter, yet the collection of Edisonia here given is the most complete yet published, and should abundantly satisfy those who admire the Froissart and Weems style of biography. Gradually we are brought to the various changes in his life; his personal qualities and indomitable love for invention are enlarged upon, and his inventions described in their order, most attention being paid to the incandescent lamp, phonograph, and kinetograph. The descriptions of most of these, however, though adorned with most flowery language, are very deficient even in a popular scientific sense. Nearly two chapters are given to the phonograph, but very little is said as to the principles embodied in its operation, and other inventions are treated in more or less the same manner. Several chapters are also devoted to the expeditions made by Mr. Edison's agents in the search for a suitable material from which to make the incandescent lamp filament, and other matter is treated at great length which has only a slight connection with the story.

The authors have in the preparation of the book had the personal assistance of Mr. Edison, who is frequently quoted, as are also many of his assistants and associates. Intimately knowing and being associated with the inventor for many years the authors have written as admiring friends and may, therefore, be perhaps pardoned for the vast amount of laudatory enthusiasm which pervades the book, whose inspiration, however, is certainly very creditable to the subject. A book treating of Edison's eventful life in more sober terms and describing his numerous inventions in a scientific manner still remains to be written. The present volume can only be considered as an elaborate and popular story written in a manner to exalt the popular sentiment according to which Edison and electricity are synonymous. As such it will serve its purpose with the general public, and is superior to the several other biographies of Mr. Edison which have made their appearance, surpassing them in completeness, while in mechanical execution there is no comparison. The glorified Edison we see through its pages, however, is not the keen and practical-minded inventor known to the electrical public, to whom, moreover, his inventions will scarcely be recognizable in the rhetorical dress in which they are here presented.

The *Current* is the name of a new journal devoted to the interests of telegraphers, of which the first copy appeared Feb. 1. The journal will be published semi-monthly by Robert Morton and Edward Delaney, from 73 Jerolemon street, Brooklyn. The editors in their announcement state that they believe there is a field for a telegraph paper containing essays, poems and general literary matter written for the entertainment of telegraphers and their families, and it is to cover this field that the paper is offered to the telegraphic public. Although the first number consists of but eight small pages it is the intention to enlarge it and make it all that a literary telegraph journal should be. The contents of the initial number includes several clever poems and some historical matter of interest to telegraphers.

The General Electric at the Convention.

The exhibit which will be made by the General Electric Company at the Cleveland Convention will be one of exceptional interest to all engaged in the electric light and power field and interested in the progress which has been made in the art during the past year. The headquarters of the company will be located at the banquet room of the Hollenden, and its interests will be under the care of the following gentlemen, members of the company's staff: From Schenectady: Messrs. S. D. Greene, J. R. Lovejoy, E. W. Rice, Jr., W. L. R. Emmet, F. O. Blackwell and H. C. Wirt; Boston: Messrs. F. M. Kimball, C. D. Haskins and H. A. Harthen; Cincinnati: Mr. W. F. Hays; New York: Mr. T. Beran; Nashville: Mr. H. H. Corson; Chicago: Messrs. B. E. Sunny, Dr. L. Bell and F. N. Boyer; St. Louis: Mr. G. F. Rosenthal; Harrison, N. J.: Messrs. A. W. Page and John S. Howell.

The exhibit will be located at the Canal Street Station of the Cleveland Illuminating Company, which company has kindly consented to furnish the necessary facilities for the operation of the machinery. The exhibit will consist, first, of a working demonstration of the new monocyclic system of electric light and power distribution recently developed by the General Electric Company. In detail, this will consist of a 230-volt four-pole, fifty-kilowatt, 575-revolution direct current motor of the latest type, which will be run by current taken from the Cleveland Company's circuits, and has been installed to operate the plant hereafter described. Belted to this motor will be a monocyclic eight-pole, sixty-kilowatt, 900-revolution, sixty-cycle generator, the current from which will operate a 15-kilowatt induction motor making 900 revolutions per minute. This in turn will be belted to a four-pole, nine-kilowatt, 850-revolution direct current dynamo, furnishing current to a load of incandescent lamps and Thomson '93 incandescent circuit arc lamps.

The current for the induction motor at 1,040 volts primary will be taken from the monocyclic generator to two of the General Electric recently designed "Type G," 60-cycle transformers of 7½ kilowatts capacity each, and will thence be brought to the motor. In addition, the monocyclic generator will have as a load a 1,000-watt and a 15,000-watt "Type G" transformer, with the secondaries connected to a suitable lamp load.

To the 1,040-volt primary circuit taken from the generators of the Illuminating Company will be connected a 20-kilowatt, 125-cycle transformer. A three-wire secondary will run from this and furnish current to 104-volt lamps. In the primary circuit a station primary Thomson recording wattmeter will be connected. The secondaries will be loaded to their capacity with incandescent lamps, Thomson '93 alternating arc focussing lamps, Thomson induction fan motors, etc. The current on the secondaries will be measured by Thomson three-wire and two-wire meters. Current from the 1,040 volt circuit will also be taken for an exhibit of the General Electric alternating street system consisting of fifty

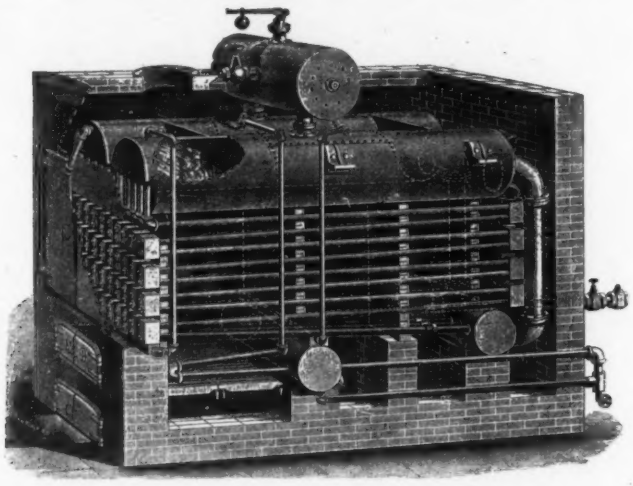
series lamps of 3½ amperes, the sockets of each being provided with the automatic paper cut-out.

The working exhibit will be further augmented by a twelve-inch hand controlled search light, which will probably be operated on some near-by roof. The appliance exhibit will consist principally of samples of the latest devices put out by the General Electric Company. These will comprise cut-outs, switches, insulators, etc., showing the excellence of the porcelain of its own manufacture; a full sample board of the new punched clip switches, showing, among others, those devised for 500-volt circuits with samples of the new key and keyless sockets.

Circulating Pipe Boiler.

The boiler we illustrate, manufactured by the inventor, J. C. Stead, 63 Kent street, Greenpoint, Brooklyn, N. Y., is based upon a well considered system of circulation which will also assure the entire deposition of sediment where it can be easily removed.

This boiler is usually seven pipes high, one row over the other, each end of a pipe being connected together by a return bend header with hand-hole plates in it, so that tubes or pipes can be put in or taken out at will in case of any damage occurring to a tube or pipe. The boiler has two steel drums; one is used as a steel bridge wall, the other used for a back header and mud drum, where the system of pipes is connected. Each coil of pipe is connected, one end to the bottom header and the other end above the water line. As these are from eight to twelve rows wide in the boiler, and as all the rows of pipes are connected in the front of this bottom header, the latter acts also as a mud drum. The mud drum is also connected with the separators which lie on top of the system of circulating pipes. These separators are usually three feet in



New Water Tube Boiler.

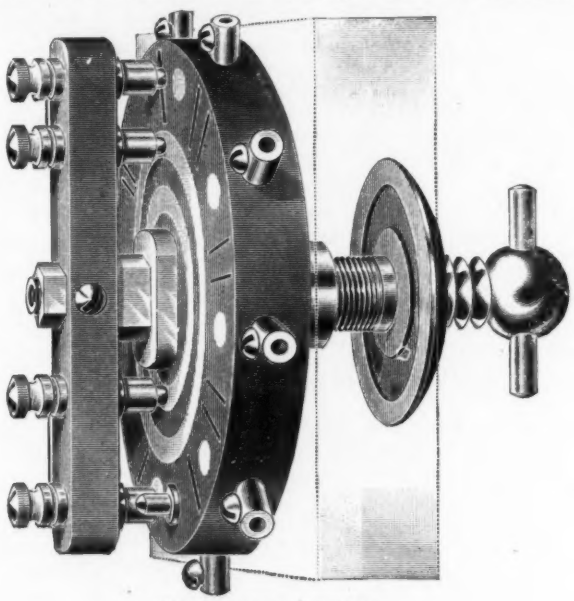
diameter by eighteen feet long, and are kept about half full of water. The water passes down at the back end of these separators into the back header, through the bottom row of pipes, leading backward and forward through the fire, each pipe inclined up until it gets into the separator above the water line. There the steam separates from the water and passes into the steam dome, which connects the two separators together. A continuous circulation is thus induced through the system of pipes and separators, whether the feed pump is in operation or not. A back feeding coil, which is placed at the back end of the wall and over the top of the separators, where the escaping gases come in contact with it, heats the water to the boiling point. When feeding, the automatic valve is closed and prevents the water going into the boiler directly; but when not feeding, the valves open, and let the water out of the boiler, circulating it through the feeding and heating coil up into the top of the separator, in the form of steam and hot water. There are about 250 lineal feet of this feeding and heating coil.

It is claimed that this inclined system of circulating tubes in the pipe boiler cannot close up with scale, dirt, or sediment, as each row of pipes, seven in number, placed one above the other, is so inclined that one end is above the water line, the other below it, and there is one unbroken line of circulation from the bottom to the top. As these pipes contain 135 lineal (and superficial) feet, if the water moves only one foot in the row of tubes, the total distance moved is 135 feet, and by the water and steam moving together no sediment or scale can remain in these tubes, but is carried off by the force of the water and steam into the mud drum and can be blown off.

Voltmeter Switch.

Among new switchboard appliances manufactured by the Electric Engineering and Supply Company, Syracuse, N. Y., is a voltmeter switch, which we illustrate herewith. When the switch is in position on the switchboard nothing is visible in front but a two and one-half inch dial plate similar to that of a safe lock, and upon which are numbered gradations corresponding to the respective number of circuits. A moveable dial carrying a pointer is rigidly fastened to a fibre or hard rubber cross bar that sweeps over the surface of the switch base. Embedded in the base are two metallic rings to which the voltmeter leads are electrically connected. The line contact points are spaced around the outer edge of the base. All wire connections of contact points and both rings radiate from the edge of the base, the connector of the inner ring being insulated by a hard rubber tube where it passes through the outer ring. The cross bar carries on each radius two plungers, connected together in pairs with fuse wire held under thumb nuts, to protect the voltmeter against any possible raise in potential. This combination completes the circuit between the voltmeter and the lines terminating in the diametrically opposite contact points, upon which the outside plungers rest.

The standard size of switch is adjustable to boards varying in thickness from three-fourths to one and five-eighths inch. To eliminate acci-

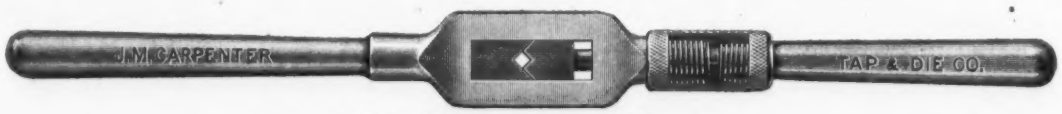


Voltmeter Switch.

dental short-circuiting of contact points through wiping of plungers over the base, two cuts are made in the base between each pair of contacts and in the path of the plungers. The chief merit claimed for this switch is that it is compact and self-contained while the only labor necessary in applying it to a switchboard is that of boring an inch hole, screwing the parts together and making the electrical connections at the back of the board.

A New Tap and Reamer Wrench.

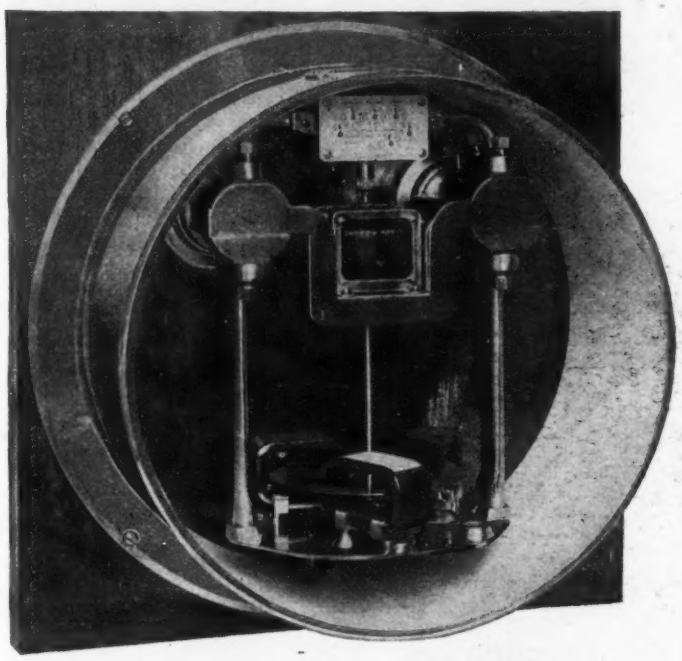
Much inconvenience has been experienced in the practical, everyday handling of tap wrenches by reason of the necessity for using a pin or small wrench to tighten the jaws of the tap wrench. The J. M. Carpenter Tap and Die Company, of Pawtucket, R. I., appears to have eliminated this disadvantage in the construction of its new tap wrench, herewith illustrated. The cut is almost self-explanatory. The neck of the stock is provided with a right-hand thread and the handle has a left-hand thread, the two threads being embraced by corresponding threads on the interior of a knurled sleeve, shown broken away in the illustration. A right-hand turn of the knurled sleeve tightens the jaws, a turn in the opposite direction loosening them. It is claimed that ample power is obtained by the use of the hand alone to grip the jaws sufficiently hard to preclude all chance of loosening while at work.



A New Tap and Reamer Wrench.

Station Output Recording Wattmeters.

In order to furnish a mathematically correct instrument to measure the full output of a station, and at the same time to automatically record the result, the meter department of the General Electric Company has devised a new recording wattmeter known as "Form G," which, though a much heavier instrument, is a development of the well-known



RECORDING WATTMETER FOR HEAVY CURRENTS.

Thomson recording wattmeter, and retains all the principles of this efficient type of recording meters.

The "Form G" recording meter is a series instrument, and takes the whole current through its field. This allows the elimination of all errors which might arise were a high capacity shunt employed. As an instance of the value of this fact, these meters, constructed for 7,500 amperes, work accurately and give excellent results, even under the comparatively small current of 500 amperes.

The field of the meter consists of a one-half turn made of copper of high conductivity, forged in the form of a wide winged yoke, the wings being of sufficient size to permit of the insertion of the supporting studs. Within the U-shaped part of this yoke revolves the armature actuating the dial mechanism. The shaft of the armature is, as in the other meters, prolonged, and carries a copper disc which revolves between the jaws of three magnets set at the bottom of the meter. The resistance in series with the armature is external to the meter. It is installed at the back of the switchboard and is there out of the way.

The meter is mounted directly on the switchboard, and is supported entirely by large studs which pass through the material of the board and are secured by heavy nuts to the connections behind. The studs thus form the mechanical support and the electrical connections. The cover of the instrument is of bevelled plate glass set in a burnished brass flange and rim fitting snugly against the board, and is provided with a felt packing to exclude dust. All the metal parts of the instrument are brightly polished, and impart to it a very handsome appearance.

As mentioned, these meters have been devised for the measurement and record of the station output. They are intended for connection with each machine or each feeder, or a single large meter may be connected for recording the total output of an entire power or lighting station.

They are manufactured for pressures of 100 and 500 volts and in capacities of 2,500, 3,750, 5,000, 6,250 and 7,500 amperes, the first, third and last being considered the standard sizes.

The 100-volt instruments have been designed for use on the three-wire system, one meter being placed on each side of the line. The 500-volt meters are for use on railway systems or in stationary power plants.

In addition to the meters described above, an arc station wattmeter for measuring the total output of an arc machine has also been devised. In this instrument, the principles of the Thomson recording wattmeter have been retained, modifications being introduced to adapt it for use in connection with constant current circuits of high potential. The rheostat used with this arc station meter is a separate piece of apparatus mounted on a marble base, and to be installed in front or behind the board. It is designed for use under extremely high pressures, especial care being given to the insulation. The arc station meters are made in four sizes: 35 and 50 lights each for 6.8 amperes and 10 amperes, and measure the output with accuracy.

The meters complete the line of General Electric station recording instruments. For the alternating system, there are the primary meters in capacities ranging up to 600 amperes at 1,000 volts, or about 10,000 lamps. For the direct current systems for light, railway and power the "Form G" meters, or larger meters of standard form are employed, and for arc systems the arc station meter.

A Northwestern Electrical Supply House.

Among the number of successful supply houses of comparatively recent birth is the Michigan Electric Company, of Detroit, Mich., which was incorporated about two years ago. From the start its business has grown rapidly, requiring frequent additions to room and stock, until to-day its quarters, here illustrated for the first time, are a credit to the electrical business.

Owing to the ability and standing of the members of this company its services have been considerably sought after by various manufacturers, and the list of specialties now handled, in addition to a general line of

A NORTHWESTERN ELECTRICAL SUPPLY HOUSE.

supplies, embraces the product of many of the largest and best manufacturers of this country, including the Simplex Electrical Company, Siemens and Halske Electric Company (of America), Walker Manufacturing Company, Detroit Electrical Works, Buckeye Electric Company and the Automatic Switch Company. The Michigan Electric Company also controls a complete line of street railway overhead equipment, which it manufactures itself.

The pronounced success of the company during the two years of its existence is undoubtedly due to the energetic and sagacious management of its president, Jos. E. Lockwood, and treasurer, Geo. A. Mansfield, of whom we give a brief sketch elsewhere.

The Handling of Coal and Ashes at the Third District Station of the Edison Electric Illuminating Co., Brooklyn, N. Y.

We illustrate herewith the coal-handling apparatus installed by the C. W. Hunt Company, 45 Broadway, New York, in the Third District Station of the Brooklyn Electric Illuminating Company. This station is situated at some distance from the coal wharves and coal is delivered by wagons. It was necessary to take the coal from the wagons, carry it to the furnaces and also to remove and dispose of the ashes. The arrangement of the machinery installed for this purpose is shown in Figs. 1 and 2. The coal is carried from the hopper underneath the sidewalk to the coal tanks above the boilers by a conveyor which upon its return, passes underneath the ash pit of the furnace and carries the ashes to a bin from which they can be drawn at will for removal. The conveyor consists of a series of gravity buckets pivoted in a double chain, and the whole system is carried on self-lubricating wheels. The buckets are so pivoted in the chain that the force of gravity keeps them always in an upright position whether full or empty and regardless of the track over which they are drawn.

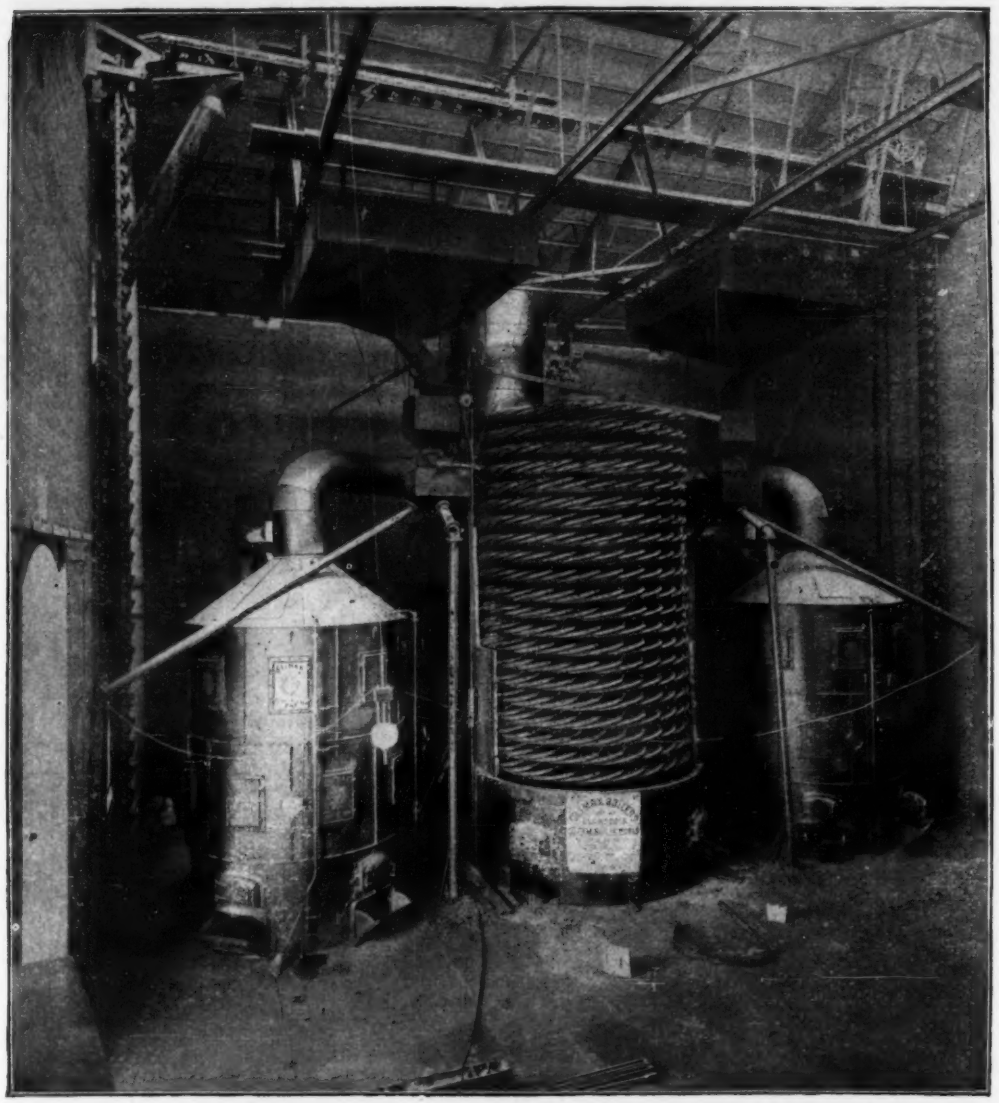


FIG. 1.—COAL-HANDLING MACHINERY IN BOILER ROOM.

The material is carried to its destination by a single conveyor in a horizontal, vertical or angular direction, all of which were utilized in this station. The change in the direction of the conveyor is made by running around curves instead of over sprocket wheels, and the whole machine is noiseless in its operation. The chain is driven by pawls instead of by sprocket wheels, avoiding the destructive wear heretofore inherent in conveyors, as the material does not come in contact with any working part of the conveyor to cause wear. The conveyor is moved slowly, the capacity being obtained by the size of the buckets and not by the speed of the chain. In this station the necessity for a special method of filling the buckets under the sidewalk will be apparent when it is considered that the buckets swing freely on pivots and might oscillate to a harmful extent or might be loaded on one side and remain at an angle during the trip. The loading is accomplished by a continuous filler which guides the coal into the buckets, filling each one evenly as it passes.

The power for driving the conveyor is located at the top line and is furnished by a ten horse power electric motor. The operating switches are placed below on the boiler room floor for convenience in starting and stopping the machinery. At this station when receiving coal at its full capacity, the power required to operate the conveyor is 4½ hp, measured at the switch. The coal is drawn from the storage bins above the boilers into weighing hoppers, from which it is spouted to the floor of the boiler room at such a distance as to be easily shovelled directly into the furnaces.

Handling ashes, either wet or dry, has heretofore been considered one of the most difficult objects to accomplish, and one of the most destructive to machinery, but in this station it is accomplished so completely by the use of a special filler placed under each boiler that it appears to be as easy to handle the ashes as the coal.

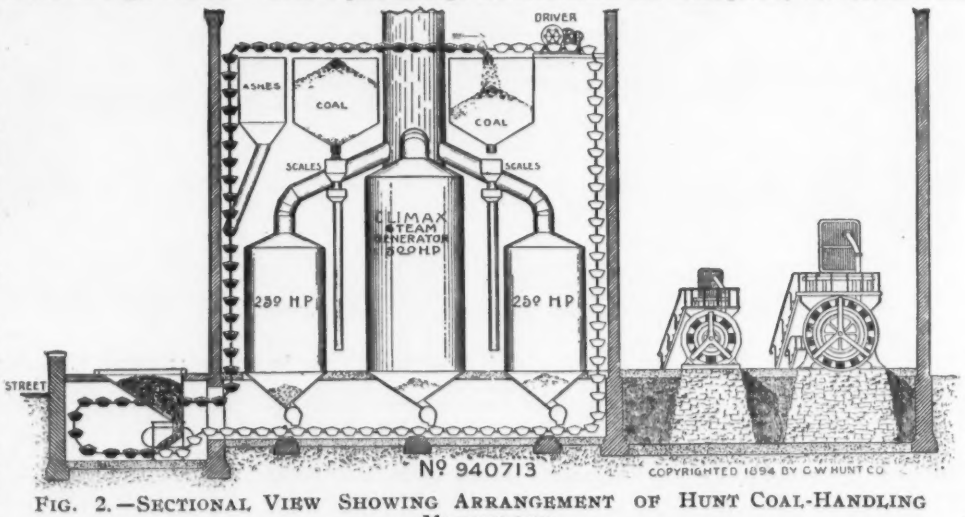


FIG. 2.—SECTIONAL VIEW SHOWING ARRANGEMENT OF HUNT COAL-HANDLING MACHINERY.

Fuel Economizers and Electric Generating Plants.

Two large Green economizers, made by the Fuel Economizer Company, Matteawan, N. Y., are used with the Babcock and Wilcox boilers at the plant of the Union Street Railway Company, Providence, recently described in the columns of THE ELECTRICAL WORLD by Mr. G. T. Hanchett as one of the best designed street railway plants in the United States. These economizers contain 9,000 square feet of heating surface and are placed immediately behind the boilers. The furnace gases pass through the economizer before entering the chimney, and impart to the feed-water —which is fed from the hot well through the economizer into the boilers—a temperature considerably above the boiling point. Independently of the saving in coal effected by the use of economizers in electric plants they have a great advantage on account of the large reserve of hot water at the evaporative point they hold in readiness to be delivered to the boiler on any sudden demands for power, thus enabling the fireman to keep an even pressure of steam, notwithstanding variable loads. The water takes about half an hour to pass through the economizer and consequently the sediment and soluble matter contained is precipitated in the apparatus where it can be easily blown off. This is a great consideration in plants where the water is at all muddy or gritty, as the surfaces of the boilers are thereby kept comparatively clean.

An Important Addition to Cleveland's Industries.

A little over a year ago The Elwell-Parker Electric Company (of America) was organized by Cleveland men, and purchased all the American patents, rights, franchises, etc., from the English Elwell-Parker Company, called the Electric Construction Company of London and Wolverhampton, England. It is now in a position to place upon the market all the various types of these celebrated dynamos, motors, and apparatus used in conjunction therewith.

These well known machines have been in use since 1881 in all parts of Great Britain, on the Continent of Europe, in South Africa, India, Australia and other countries, where large and important installations are in very many cases composed of Elwell-Parker machinery. We may specially call attention to the Liverpool Overhead Railway, the Manchester Corporation, the London Metropolitan Electric Supply Company the London General Post Office, the Liverpool Electric Supply Company, Oxford Electric Company, Oxford, Eng., etc., all of which are large and very efficient generating and distributing plants. The Liverpool Overhead Railway Company's electric generating and traction plant has established a reputation for efficiency and all-around reliability.

This company's generators are now doing the majority of the electrolytic work in Great Britain, and its system of long distance transmission and distribution by direct currents is in successful operation in a considerable number of places.

The American company is prepared to manufacture generators of 1,000 hp and under; motors, transformers, automatic switches and all other appliances necessary to the industrial application of electricity, including long distance transmission and distribution by both alternating and direct currents. It also has facilities for the manufacture of the large generators and gearless motors for heavy electric railway work, of which it makes a specialty. The highest degree of perfection in electrical and mechanical design, materials and workmanship, and an extremely high efficiency are claimed for all its machines.

The officers are at present as follows: F. C. Phillips, president; E. B. Phillips, vice-president; Alex. E. Brown, secretary and treasurer, and E. S. W. Moore, superintendent. Mr. F. C. Phillips has had a very large and varied experience in every branch of electrical engineering abroad and especially in England, and Mr. Moore has had a similar experience but confined to Great Britian. Mr. E. B. Phillips has had fourteen years' experience in electrical work in this country. Mr. A. E. Brown is the inventor and manufacturer of the Brown hoisting and conveying machines that have done much to revolutionize the handling of large quantities of ore, coal, pig iron and other like raw materials.

Wrought Iron Field Dynamo and Motor.

We illustrate below the improved Adams dynamo and motor, manufactured by the E. G. Bernard Company, Troy, N. Y., which possesses the distinctive feature of a wrought iron field magnet forged in a single

IMPROVED ADAMS DYNAMO.

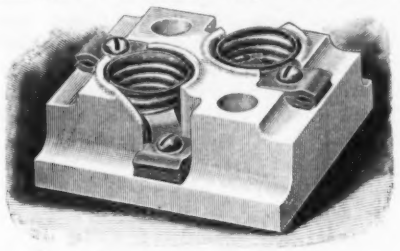
piece, thus eliminating all joints in the magnetic circuit other than the air-gap between field and armature. This construction secures a very strong magnetic field with a small number of ampere-turns, and reduces the windings and machine work to a minimum, enabling the manufacturers to produce a high-grade machine at comparatively low cost.

The armature is a Gramme ring of large diameter, usually wound with a single layer of wire. The cooling surface is, therefore, abundantly large, conducing to low heat losses and smooth running, and the resistance of the armature winding is very low, thus enhancing the efficiency of the machine. Mica insulation is used exclusively.

The commutator is of the usual high-grade construction, tempered-copper and mica being used. The journals, brush-holders and other details conform to the latest and best engineering practice. Nothing particularly novel is attempted in the type of the machines, the aim being rather in the direction of high-class designing and workmanship. The dynamos are compound-wound to regulate for all loads from zero to maximum; the motors are plain shunt wound.

New Cut-Out and Lamp Socket.

We illustrate a new cut-out and socket recently placed on the market by the General Electric Company, which embody several interesting improvements. The former, a double pole single or double cross-over branch plug cut-out, is so constructed as to facilitate its attachment to wires already placed, holding them well apart where they cross. It is a very compact device, of the well-known plug fuse type, the fuse being held in a brass-covered screw plug, inserted in the female screw shell secured to the porcelain. Replacement of the fuse entails no further labor than is involved in the unscrewing of the fuseless plug and the



NEW PLUG CUT-OUT.

insertion of a perfect one, which feature renders the cut-out of especial value in residences and places where fuses have to be cared for by unskilled persons.

The lamp socket is the outcome of a well-founded knowledge of the conditions which should be fulfilled by a first-class socket, and while containing the best features of the older sockets, embodies also improvements which ensure the best results in practice. It is smaller than the well known Edison socket, and in construction is extremely simple. The entire base is formed of one porcelain piece of conical shape, and so ridged perpendicularly that there is practically no possibility of a

NEW KEY LAMP SOCKETS.

short circuit between the working parts. The key may be turned in either direction. The central connection for the lamp base is a well-tempered contact spring against which the lamp is screwed and a good contact made, while the spring serves to prevent the lamp from working loose. The wires are connected as directly as possible, needless joints being avoided. The insulating collar between the screw shell and outside shell is firmly locked in place and extends one-sixteenth of an inch beyond the shell.

Every precaution has been taken to produce an appliance the usefulness of which cannot be impaired by the ordinary carelessness of wiremen or fixture fitters. The porcelain used in these appliances is manufactured by the General Electric Company in its own porcelain works at Schenectady, which were especially constructed for the production of porcelain possessing the high insulating qualities for which the stringent conditions of the government specifications and insurance rules call.

The Power Plant of the Baltimore & Ohio Belt Line Tunnel.

The Baltimore & Ohio Railroad tunnel plant in Baltimore is approaching completion, and will go far toward deciding definitely the question as to whether electric traction is adaptable to steam railways as a substitute for steam locomotives.

The Belt Line Road, as it is termed, is but a short cut connecting the main tracks of the Baltimore & Ohio Railroad at two points, and its object is to avoid a long detour about the city. This is calculated to save from twenty minutes to half an hour in the running time between New York and Washington, and it will besides enable the Baltimore & Ohio Railroad Company to place one station near the present Union Station of the Pennsylvania Railroad and a second one in the very heart of the business centre of the city. The Belt Line Road is about seven miles long. It begins near Bayview, to the east of the city, runs several

miles through deep cuts along the northern edge of the city until it swerves around to the Jones Falls embankment, west of Oak street; it crosses the valley of this stream, the tracks of the Pennsylvania Railroad and the Baltimore & Lehigh Railroad on a large bridge, and a short distance beyond this it enters the tunnel which follows Howard street through the city to the present Camden station. This tunnel is 7,430 feet long, and cost the Baltimore & Ohio Railroad Company between $7,000,000 and $8,000,000.

The motive power is furnished from one station located near the end of the tunnel. This power house was equipped throughout by the General Electric Company, which is making the test of electric traction at its own expense, and if the result is in every way satisfactory the Baltimore & Ohio Railroad Company will purchase the plant complete.

In addition to the traction plant an electric lighting plant is installed to supply about 2,000 incandescent lamps, which are placed throughout the tunnel. As there will be no smoke in the tunnel it is intended to paint its interior white, so that when illuminated by incandescent lights it will not be necessary to light the lamps in the cars of passing trains. The generators will be driven by Armington and Sims engines, and the steam will be furnished from improved Root water tube boilers. The boiler room of this plant is most interesting and includes the most modern appliances. Twelve Root boilers are arranged in six batteries, three batteries on each side of the room. Each of two flues which run along the opposite walls back of the boilers carries the heated gases to economizers which utilize part of their heat to raise the temperature of the feed water. The gases then pass into a Sturtevant pressure fan which expels them through a short stack into the air. This fan establishes an induced draft, causing the air to pass rapidly through the grate bars and coal, thus promoting combustion more or less rapid according to the speed of the fan, which is regulated according to the demand for steam.

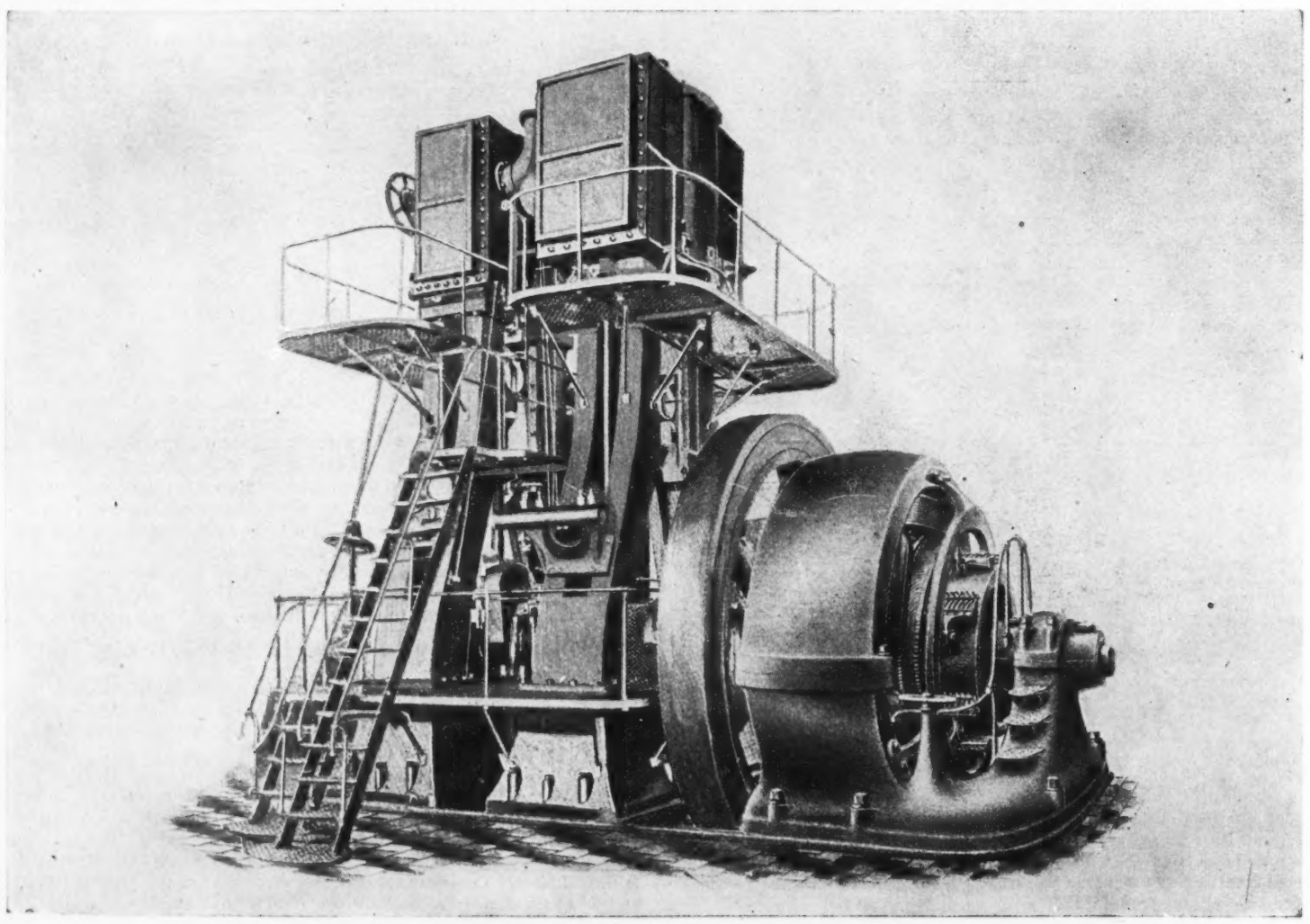
A coal and ash handling device, made by the C. W. Hunt Company, New York, carries the coal direct to each of the boilers and also carries the ashes away from the ash pits.

As the General Electric Company is relying entirely upon the success of this plant for the sale of it to the Baltimore & Ohio Railroad Company, the greatest care was necessary in the selection of all the appliances, and to illustrate this point the order was not placed for the boilers until after the General Electric Company had thoroughly tested them in two of its Lynn plants.

A Representative Industrial Plant.

The Walker Manufacturing Company began operations in the field of electrical manufacture in February last, and the first electrical apparatus produced—the now well-known railway motor—was put in service the following May. Although new in the electrical field, this company has enjoyed for several years a most enviable reputation in the construction of cable railway equipments, power transmission plants and all kinds of heavy machinery. Notwithstanding the fact that the character and quality of its electrical apparatus was entirely unknown, and in spite of the severe commercial stringency of the past year, the company has done a business beyond its expectations. It has achieved a very encouraging and almost unlooked-for success with its street railway equipments, and has also been furnishing apparatus for traveling cranes, swinging bridges and power transmission plants. Contracts are on hand for a number of large direct-coupled railway generators—three 500-kw and two 750-kw, besides a number of smaller ones. It is also furnishing dynamos for incandescent lighting, which are particularly well adapted for direct-coupling for isolated work in large office buildings and factories, and an arc-light dynamo of 125 2,000-cp lamps capacity is being perfected, and will be placed upon the market very shortly. The older arc-light plants throughout the country are beginning to require renewal of machinery, and the universal demand is for more efficient and larger units than formerly used, and the arc dynamo of the Walker Manufacturing Company is intended to meet these requirements. Its design is based on a long experience in arc light work. It will run at a speed such as to make it available for either direct-coupling or belt driving, and will regulate perfectly up to its full capacity of lamps without requiring an external regulator. It will supply its full complement of 125 2,000 cp lamps with a consumption of but 90 hp. The company is also contemplating taking up in the near future the manufacture of an improved form of arc lamp.

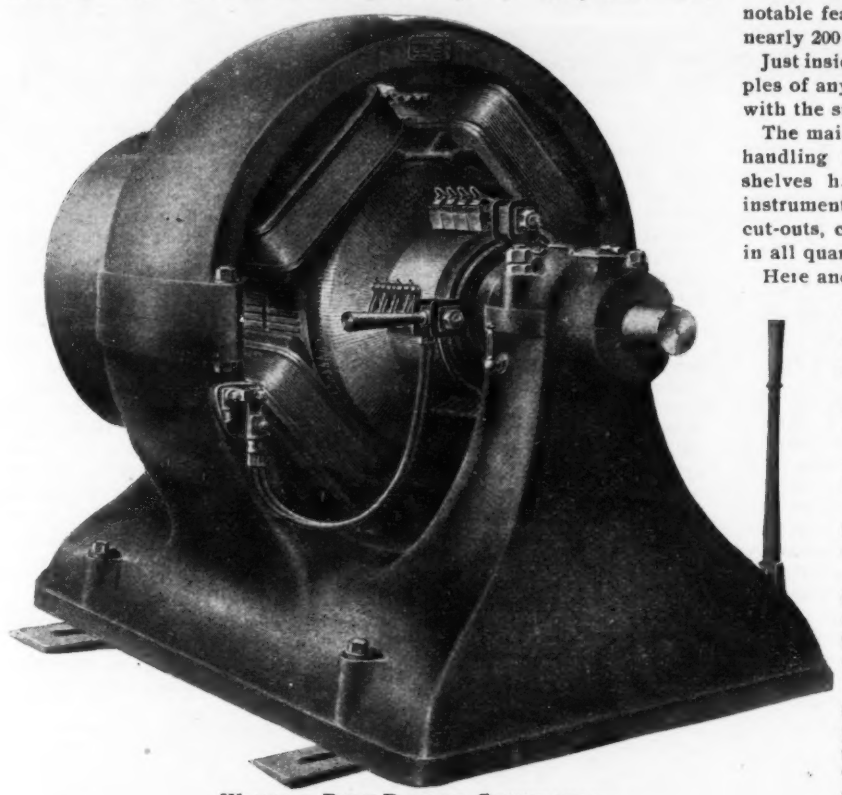
The works of the Company are situated on the lake at the foot of Waverley avenue, in Cleveland, O., about twenty minutes' ride from convention headquarters. The plant is modern in all its appointments, and is one of the largest and most complete in the country. The machine shop consists of three bays, each 57 feet wide by 430 feet long, and contains a 30-ton traveling crane which moves its entire length. Iron galleries at either end are fitted up for some of the lighter work. The testing department occupies one end of one of the machine shop



Walker Direct-Connected Generator.

bays and is fitted up with all necessary appliances for testing the apparatus turned out. The tracks of the L. S. & M. S. Railway enter the testing room below the floor level, so that machinery can be loaded by the large cranes directly from the testing room on to the cars.

The company's two large foundries are perfect in their equipment, containing several large cupolas, spacious core ovens, and a number of traveling cranes of from five to thirty tons capacity. Fifty tons of iron



WALKER BELT-DRIVEN GENERATOR.

can e poured at one heat into a single mould. The company is, therefore, fully equipped to make castings of any size or grade. The pattern shops occupy a large two-story building, well supplied with modern wood-working machinery. The works have a present capacity for the profitable employment of from 3,000 to 4,000 men with plenty of room for increase when necessary.

A Typical Supply House.

Whenever one is called upon to speak of Chicago or any of its remarkable establishments, the first thing he has to guard against is the use of superlatives, for the reason that the inhabitants in other sections of the planet are likely to ascribe to what is simple fact the rather always to be avoided quality of "brag." In and about the city itself, however, the visitor finds nothing that does not partake either of the colossal, or of the marvelous, when compared to the usual degrees through which things material develop into perfection.

In the ordinary sense there is nothing specially interesting in a "supply house," so-called; but in the unique establishment of the Electric Appliance Company, of Chicago, there are many elements of genuine interest.

But a few years ago this name had never been heard of. To-day it is one of the best known in the country wherever electric lighting and railway systems have been installed.

The exterior bears the ear-marks of the originality that has been a notable feature of the company's existence. It is a three-story building, nearly 200 feet deep.

Just inside the spacious door is arranged an exhibit board holding samples of anything you want, and so displayed as to instantly impress one with the superiority of the Appliance Company's line of specialties.

The main store, shown in the illustration, is admirably arranged for handling the immense trade daily transacted there. The well-filled shelves hold everything known to modern electrical science—testing instruments, knife switches, snap switches, arc and incandescent lamps, cut-outs, cleats, sockets, annunciators and house goods of all kinds and in all quantities.

Here and there a reel of O. K. weatherproof wire, for which the company is Western agent, and everywhere coils and reels of well-known "Paranite," with which brand of insulated wire the name of the Electric Appliance Company is so intimately associated.

Back of this main room the always-busy officers are located. This part of the store is a hive of industry at all times.

The shipping room—the nerve centre of a mercantile house—is another scene of unceasing activity. Through this department scores of orders, large and small, are daily filled.

The basement forms a great store house for the company's goods. Here is kept at all times ample stock to fill every order.

The success of the Electric Appliance Company has been gradual, and for that reason all the more certain. Each new customer has been handled as though he were the only one; thus the company has gained strength through the very people with whom it has dealt—a high compliment to its integrity.

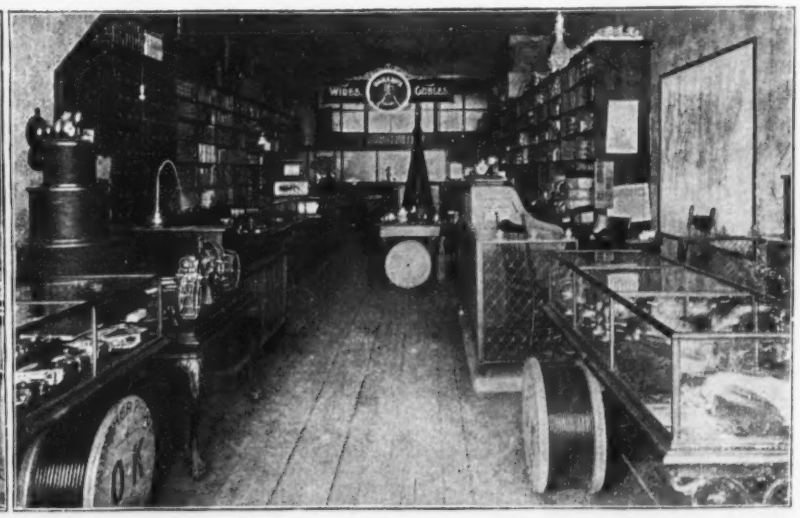
The officers of the company displayed good judgment at the start by selecting only those specialties that would stand hard pushing. A good thing cannot be too well advertised; a poor thing meets death in the light of publicity and competition. The Electric Appliance Company early appreciated this fact, hence their selection of such leaders as the Packard transformer, the Packard incandescent lamps, "O. K." weatherproof wire, "Paranite" insulated wire cord cables, the Allen soldering stick, and other specialties which their hustling qualities have brought into prominence.

For each of these the company has repeatedly claimed great economic features, and practical experience has justified the claims.

During the World's Fair and the period of depression that linked itself with '93-4, the company was one of the few that pushed aggressively forward. It lost no opportunity to supply the trade with just what it wanted, and at prices that pleased. Now its volume of business is enormous and daily growing, so that it will soon have to seek more commodious quarters.

It is always a pleasure to record every honest success. It is a double pleasure to present at this time the reason for the claims of the Electric Appliance Company on the patronage of every one from whatever section of the country—namely, that it has won its success on the merit of its goods, the absolute integrity of its dealings and the popularity of its officers and salesmen.

PACKING ROOM.



THE ELECTRIC APPLIANCE COMPANY.

MAIN STORE ROOM.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Feb. 15. 1895.

ELECTRICAL STOCKS do not improve much. The speculative community continues to take an unfavorable view of the general situation, and a lower range of prices is freely predicted. There is a good deal of general selling, but it is in about the proportion of two-thirds short, and only one-third long. Nonetheless, even this is discouraging, and tends to increase the dread of further depression in prices.

GENERAL ELECTRIC, however, does not look high enough to warrant fears of a serious decline in its quotation. With no floating debt to look after and impede its progress, the company is easily holding its own, and the management scouts the idea that it is in danger of such a collapse as has occurred in several other industrials. There is, according to officials, nothing in connection with its affairs to bring about any such disaster. It is being managed with the utmost care, and on the same basis as a purely private enterprise. Naturally, it is abso utely impossible to tell to what low level its market quotation may descend, but it is not hard prophesying to declare that those who hold General Electric stock the longest will not regret their steadfastness. True, the company is now passing through a period when earnings are smaller than its management should like to see, but goods are being sold at a profit, and a small amount of money is being made every month. One recent good deal was the closing of a contract with the New York, New Haven & Hartford Railroad Company for the electrical equipment of its Nantasket branch; this involves $70,000, and the General Electric Company met with practically no opposition. This is a very important transaction, in that the New York, New Haven & Hartford Railroad Company as already stated in these columns contemplates introducing trolley equipment on many of its shorter branch lines and much of its suburban trackage, and the success of the first line, as equipped by the General Electric Company, means the placing of further profitable orders with it.

WESTINGHOUSE ELECTRIC issues maintain their own with ease. The company this week came into complete possession of what is probably the most complete and extensive manufactory in the world, the last of the group of seven buildings having been turned over by the contractors. There are now 600 men at work in the new factory, and in the erection of the new machinery and tools, and the care of the materials arriving from the Pittsburgh and New Jersey works. The extent of the plant can be judged by the size of the main building, which is 754 feet long, and 231 wide, and can easily hold two trains of cars. When in full operation the various buildings in the establishment will require the presence of 3,000 to 4,000 operatives. The machine tools are among the finest ever made in this country. All shafting and machinery are driven by Telsa alternating current multiphase motors, and the whole plant in full operation furnish one of the best illustrations of electric power distribution to be found in the country. The possibilities of the new plant for economical and profitable manufacture are practically unlimited, and great things in the way of money making are expected in the near future. It is not strange, then, in view of these bright prospects that the preferred and common stock should not be more affected by adverse business conditions, and it is reasonable to expect that better prices will soon obtain when the company's strength of position is more fully appreciated.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Chicago Edison Company	100	128	130
Edison Electric Ill., New York	100	96½	97½
" " " Brooklyn	100	108	110½
" " " Boston	100	125	127
" " " Philadelphia	100	120	125
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	32	34
General Electric	100	28⅛	29
General Electric, pref	100	61	66
Westinghouse Consolidated, com.	50	30½	32½
" " pref	50	48½	49
BONDS.			
Edison Electric Ill., New York	1 000	108	109
Edison Electric Light of Europe	190	75	85
General Electric Co. deb. 5s	1,000	88⅛	89
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	191½	192½
American District Telegraph	100	45	49
American Telegraph & Cable	100	92	93
Central & South American Telegraph	100	117	120
Commercial Cables	100	135	140
Erie Telephone	100	46	46½
Gold & Stock Telegraph	100	104	110
Mexican Telegraph	100	190	195
Mexican Telephone	100	75	80
New England Telephone	100	67	69
New York & New Jersey Telephone	100	97½	99
Postal Telegraph-Cable	100	55	58
Western Union Telegraph	100	87⅛	88

WESTERN UNION TELEGRAPH has been rather freely sold of recent days, the "street" theory being that it was too high around 87 for a stock on which dividends will come down sooner or later. That time, however, with the big surplus and the company's prestige, is likely to be a good long time a-coming, and it would seem that the bears, with the scorchings they have received in prior attempts to down the stock, should by this time know the danger of assailing a stock which, by reason of the small floating supply, can be so easily cornered. Western Union has not as yet suffered much from the bear campaign. Several old buying orders have appeared to discomfit the down grade operators, and they have not as yet succeeded in demoralizing quotations.

ELECTRIC STORAGE stock, that of the Consolidated Company, is easily commanding its old figures, the reports concerning the company being of a consistently flattering character. The latest is to the effect that President Gibbs is conducting an important deal that will prove of the same favorable character as the recent amalgamation. In this event Electric Storage can be depended upon to greatly appreciate in value.

EDISON ELECTRIC ILLUMINATING, of New York, is now selling ex-dividend. January earnings, just reported, show that the same good progress as previously reported is being continued. Gross earnings were $166,953, an increase of $31,768; operating expenses, $73,249, an increase of $14,909; net earnings, $93,703, an increase of $16,859.

POSTAL TELEGRAPH remains unchanged in quotation, but the company is making a good record for efficiency of service. During the recent heavy storms its service by dint of hard effort was hardly interfered with. The company is projecting various extensions. An important line soon to be constructed will extend form Massillon, O., to Chicago, a distance of 400 miles. A number of cities, of 10,000 and 12,000 population, not now in the Postal Company's lines, will then be connected with it.

BELL TELEPHONE remains about the same as last week. The 3,368 shares not taken by the stockholders under the recent offer of treasury stock, was sold at auction this week. The first bid was 185, and the first sale was 761 shares at 191. The next sale was at 190, the third sale at 190¼, and the remaining 1,748 shares were disposed of at 189¼ for the account of a pool of investment orders from half a dozen houses. The directors of the company state that the result of the auction sale was very satisfactory, all things considered, but they have not as yet acted on the question of selling more stock in similar fashion. The annual meeting of the company will be held on March 26 next, and some action will then be taken looking to the determination of the company's future financial policy.

ELECTRIC TRACTION stock, outside of New York stocks, are quite active. Philadelphia advices have it that the continued strength of the traction stock is the only feature of the local market, the railroad shares and the unlisted specialties being absolutely neglected in their favor. The prediction is circulated there that Baltimore traction will begin by the payment of dividends by January, 1896. There is renewed talk in Boston of lively times in West End on developments in connection with control.

ELECTRIC TRACTION STOCKS.

	Bid.	Asked.
Union Ry. Co. (Huckleberry)	115	125
Brooklyn Traction, com	10	12
" " pref	54	58
Long Island Traction	8¾	9
Rochester St. Ry	36	38
Columbus St. Ry	48	50
Louisville St. Ry. com	37	39
" " " pref	87	88
Cleveland Electric Ry.	59	60
Cleveland City Ry.	68	70
North Shore Traction.	23	25
New Orleans Traction.	15	16
New Orleans Traction pref	55	58
Worcester Traction com.	11	13
" " pref.	78½	80
Metropolitan Traction, Philadelphia.	98¼	98½
Philadelphia Traction.	88¼	88½
People's Traction.	47¼	48
Binghamton R. R. common	100	—

BONDS.

	Bid.	Asked
*Union Ry. 1st. mtge 6s.	105	108
*Westchester Electric 1st. mtge. 5s.	98	101
Rochester St. Ry. 1st. 5s.	95	97
*Columbus St. Ry. 1st 5s.	95	97
Columbus Crosstown 1st. 5s.	95	97
*Binghamton Railroad Co. 5s	99	100

* With accrued interest.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD.
253 Broadway, NEW YORK, Feb. 18, 1895.

H. B. COHO AND COMPANY, of 203 Broadway, New York, have sold to the Conduit Wiring Company two 50-kw direct-connected Mather generators for the Lauderdale Building, Providence, R. I. Messrs. Pattison Brothers are the engineers on this work.

JARVIS B. EDSON, 87 Liberty street, New York, has received a copy of a report made by a board of Italian naval officers, in which the Edson pressure recording and alarm gauge is strongly endorsed. As a result an initial order for gauges from the Italian Government has been received.

A BILL has been introduced in the New York legislature by Assemblyman Fitzgerald requiring the appointment of an electric meter inspector for New York State, at an annual salary of $2,500, to be paid by the electric light companies. The bill also provides for deputy inspectors at works where meters are made, and prohibits electric light companies from charging rent for meters.

THE INTERIOR TELEPHONE COMPANY, of New York, (which handles the Colvin system) on Feb. 12 brought suit in the United States Circuit Court for the Southern District of New York, against the Tucker Electrical Manufacturing Company and against James R. Strong, president, and Thomas McCoubray, as individual co-defendants, for the infringement of patents Nos. 513,305 and 524,524, granted to Frank R. Colvin, and owned by the Interior Telephone Company.

THE J. C. AYER ESTATE will erect a 9-story, fire-proof building on the corner of Broadway and Franklin street. Frederick A. Southack & Co. are agents for the property. The 13-story buiding going up on the corner of Broadway and Broome street, the 9-story Baudoine building, corner of Grand; the 12-story building to be put up by Havemeyer at Broadway and Prince, and the 9-story building to be erected at Broadway and Howard street by Boehm and Coon, are all to be equipped with electric lighting plants.

THE BROOKLYN STRIKE continues to afford spasmodic bits of divertisement of a slightly sensational character. It is reported now that the Grand Jury has indicted President Norton and Superintendent Quinn, of the Atlantic Avenue Railway Company, on charge of violating the ten-hour law. Several of the strikers swore to having been made to work for the company eleven and eleven and a half hours within a period of twelve consecutive hours. Mr. Quinn expresses himself as entirely able to successfully refute the charge.

MR. EDWARD BERGTHEIL, of the firm of Bergtheil & Young, electrical engineers and contractors, of London, England, is now visiting the States with a view to arranging increased facilities for their English and European customers in connection with some American specialties which they introduced to those markets, and encouraged by their previous success, is prepared to negotiate for other first-class agencies. He can be communicated with at 35 Pine street, this city, or seen there on his return from the Cleveland Convention, which he is attending.

General News.

NEW INCORPORATIONS.

THE GARRETT ELECTRIC LIGHT COMPANY, Indianapolis, Ind., capital stock $20,000, has been incorporated.

THE KRAMER ELECTRIC MANUFACTURING COMPANY, Chicago, Ill., capital stock $100,000, has been incorporated by Edward Kirch, Frank A. Kramer and Max C. Krueger.

THE BLOOMINGTON GAS, ELECTRIC AND STEAM HEATING COMPANY, Bloomington, Ill., capital stock, $50,000, has been incorporated by Sam. P. White, R. T. McDonald, Jacob P. Smith, John J. Patterson, George McIntosh, John Eddy and A. E. Demanges.

THE ELECTRIC CONSTRUCTION COMPANY, Wilmington, Del., has been formed to carry on a general construction and electrical engineering business, make and sell dynamos, motors, electrical instruments, lamps and general electrical supplies. J. Wesley Morris, and Herman Devenney are the organizers.

THE MARION WATER COMPANY, Jersey City, N. J., capital stock $250,000, has been formed to construct, maintain and operate electric light works, gas works and water works, in Marion, O., and elsewhere, etc. Alfred C. Brown, Lewis Halleck, Jr., Robert H. Dillingham and Herbert F. Hatch, East Orange, and Chas. N. Brown, Jersey City, N. J., are the promoters.

TELEGRAPH AND TELEPHONE.

CORDELE, GA.—D. H. Ledbetter will establish a telephone system.

MARTINSVILLE, IND.—A telephone exchange will soon be established.

PARIS, TEX.—The Anthony Telephone Company will construct a system.

ARGENTILE, KANS.—A petition has been presented by G. W. Simons, Wm. McGeorge, T. M. White and others, leading business men, asking for a franchise to establish a telephone exchange. It is proposed later on to connect the local exchange with the two Kansas Citys.

SNOW HILL, MD.—The Snow Hill Telephone Company has been organized by G. S. Bridges, who will construct a system. He wants from 100 to 150 telephones, 50 miles of copper or iron wire, 1,500 brackets, 1,500 insulators, seven miles (two conductors) submarine cable, 1,500 poles (cypress or chestnut) 20 to 25 feet long.

ELECTRIC LIGHT AND POWER.

SHELBYVILLE, ILL.—The Council is taking steps in the direction of purchasing an electric light plant.

ALBANY, N. Y.—Address the City Clerk concerning a municipal electric lighting plant to be established.

HUMBOLDT, TENN.—A bill is before the State legislature authorizing the issue of $15,000 water and light bonds.

PROCTOR, VT.—Bids will be asked soon for an extensive electric plant to be used for lighting and quarrying purposes.

KENTON, O.—Municipal lighting is being strongly agitated here, and it is very probable that the city will put in a plant.

GERMANTOWN, PA.—The George Nugent Home for Aged Baptist Ministers, on West Johnson street, will be lighted by electricity.

GUTHRIE, OKLA.—St. Louis capitalists have purchased the Guthrie electric light plant. They will add more incandescent lights.

MOORESTOWN, N. J.—Elwood Hollinshead, Jr., is building a fine residence on Chestnut street. It will be fully equipped with electric lights.

BROOKLYN, N. Y.—The Kings County Wheelmen will erect a new club house on Bedford avenue which will be lighted by electricity. Cost $35,000.

SILVER LAKE ASSEMBLY, N. Y.—The Silver Lake Railway Company will build a pier out into the lake on which a band pagoda is to be built decorated with electric lights.

GALESVILLE, WIS.—D. M. Benton & Co., recently granted a 20-year franchise by the City Council, are making arrangements to extend the electric light lines all over the city.

BROCKTON, MASS.—The Edison Electric Illuminating Company, of Brocton, capitalized at $100,000, became the property of the Industrial Improvement Company, of Boston, on Feb. 6.

RAHWAY, N. J.—The Rahway Electric Light and Power Company has been organized. Capital, $200,000. Stockholders, Capt. W. Boynton, of Woodbridge, Jackson Jacques, of Rahway, and others.

NORWICH, CONN.—In the legislature at Hartford Gardiner Greene, Jr., of Norwich, presented a resolution to allow the city of Norwich to establish and maintain an electric light and gas plant.

WELLSVILLE, O.—The Wellsville electric plant, which was purchased a few days since at receiver's sale by Mr. Homer McLaughlin, of East Liverpool, O., it is understood will be enlarged and improved by the addition of a new engine, new dynamos, etc.

TECUMSEH, MICH.—The Common Council will receive proposals for furnishing, operating and maintaining from 35 to 40 double arc 2,000-cp electric lamps on the streets of the village for a term not exceeding five years. Address W. J. Ingersoll, clerk.

WESTCHESTER, PA.—A shirt factory, with electricity as motive power, is one of the possibilities of the near future for Westchester. L. B. King is one of the prime movers in the matter, and he in now looking for a suitable building for such an establishment.

BALTIMORE, MD.—Sealed proposals will be received by the Construction Committee of the Underground System of the Police and Fire Alarm Telegraph and Police Patrol, until March 1, 1895, for the complete electrical equipment of the electrical subways of the police and fire alarm telegraph system of Baltimore City. Copies of the agreement and specifications under which the work is to be performed can be obtained at the office of the engineer by depositing $500, which will be returned.

THE ELECTRIC RAILWAY.

MANCHESTER, N. H.—The Manchester Electric Railway has placed bonds to the amount of $250,000 with George A. Fernald & Company, of Boston.

HARTFORD, CONN.—At a meeting of the Council the street committee reported favorably on the petition of the Central Railway and Electric Company to extend its tracks to the city lines.

WASHINGTON, D. C.—The Washington and Baltimore electric line, 27 miles long, will be operated by the block signal system, and the distance covered in 35 minutes. The entire cost will be $1,000,000.

PORTSMOUTH, VA.—The street committee, to whom was referred the application of the Portsmouth Street Railway Company for extension of lines and use of certain streets, recommended that the petition be granted.

CHESTER, PA.—The People's Railway Company expects to build its trolley road between Chester and Rockdale during the coming summer, and is asking for an extension of time on the franchise granted by Upland Borough Council.

ATCHISON, KANS.—The Atchison Electric Street Railway Company has decided to make improvements to the plant to the extent of $20,000. Several new engines and dynamos will be put in and the line will be extended several miles.

LORAIN, O.—A. R. Reynolds and Henry Randall, of Cleveland, have made a proposition that if the Council will grant at once a franchise they will complete by July 1 an electric street railway from Broadway to the extreme eastern limits of the city.

BRADFORD, PA.—Promoters of the electric railway to run from Bradford to Scottdale expect to include a branch to Mount Pleasant, and to continue the line to Huff City, where connection will be made with the Greensburg & Hempfield Street Railway.

CHARLEROI, PA.—The eastern part of the county will have an electric railroad built during the coming summer. Agents of the Charleroi, California & West Brownsville Electric Railway have succeeded in getting grants for the entire lower end of the line.

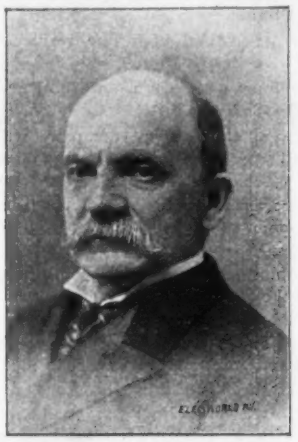
WHITE PLAINS, N. Y.—The New York, Elmsford and White Plains Railway Company has been granted a franchise to construct and operate an electric railway through Railroad and Central avenues, Broadway and Lake street. The company forfeits $2,500 if the road is not completed by Aug. 1.

LA SALLE, ILL.—The General Electric Company on Feb. 25 sold the Ottawa Electric Street Railway to a home syndicate represented by Mayor Schoch for $40,000 in bonds, the condition of the contract requiring the local men to invest $20,000 additional in improvements. The property will be transferred March 1.

MONTGOMERY, ALA.—W. B. Rommee has been appointed receiver for the Seelye electric line on application made by the Westinghouse Electric Company and Wright & Lindsley, of New York, who are creditors. The operation of this road was recently suspended, but the receiver expects to commence running cars in a few days.

Personal Notes.

WILLIAM BROOKFIELD, the recently appointed Commissioner of Public Works, of New York City, is well-known to the electrical public as the owner of the Bushwick Glass Works, and manufacturer of glass insulators for electrical purposes, which he was the first to successfully make with a screw thread. The Bushwick Works was started by Mr. Brookfield and his father in 1864, and have been continuously in operation ever since. Mr. Brookfield has been president of the Eastern Association of Glass Manufacturers, and is now a member of the Union League, Downtown, Fulton and Lawyers' clubs, the New York Chamber of Commerce, Board of Trade, and the Produce and Consolidated Exchanges. He has also taken an active interest in politics for many years, and was a charter member and one of the presidents of the Republican Club, president of the Republican County Committee for several years, and chairman of the Republican State Committee during 1892, 1893, and 1894. His whole career has been marked by high integrity and an energetic business policy, which have combined to make him the successful and highly respected man he now is.



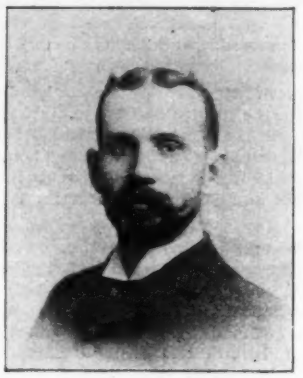
A REPRESENTATIVE CHICAGO HOUSE is the Electric Appliance Company, which recently has attracted a great deal of attention in electrical circles in the West as well as in all sections of the country, and enjoys the distinction of having two of the ablest men in the supply business at its head. Mr. W. W. Low, president of the firm, is universally known among central stations, street railways and the fraternity generally. He was first connected with the old Detroit Electrical Works in the capacity of clerk; later he came to Chicago and entered the supply business, and in 1891 embarked with Mr. Stacey in his present company. Formerly Mr. Low traveled extensively for the company, but of late has attended to the business in Chicago, where he has made his home. Thos. I. Stacey, secretary and treasurer of the Appliance Company, has made a great reputation for himself. Although but 25 years of age, youth has proved

W. W. Low.

Thos. I. Stacey.

in his case the boon that so many ascribe to age and experience alone. Entering the supply business as long ago as 1887, Mr. Stacey early determined upon his career, and showed a natural inclination for the business in which he engaged. In the capacity of stenographer he thoroughly mastered every detail of the business, and learned the essentials of success. Promotions came rapidly, so that when the Electric Appliance Company was formed, Mr. Stacey was well qualified to guide the infant aright. Day after day, month after month, and year after year, he has paid the closest attention to the business and financial department of his business, and his efforts have crystalized into unusual success. Mr. Stacey enjoys the distinction among those who know him as being one of the shrewdest and ablest business men in harness, a reputation rarely attained by a man of his age.

ONE OF THE PIONEERS in the introduction of electric lighting is Jos. E. Lockwood, whose portrait we present herewith, he having entered the employ of the United States Electric Lighting Company in January, 1880. Soon after this he perfected the first carbon filaments used in the Maxim incandescent lamp. He installed the first incandescent electric light service in New York City at the Equitable Building and vicinity, next introduced the Maxim incandescent and Weston arc systems into Europe, and in 1881 represented the United States Company at the first International Electrical Exposition held in Paris. He afterwards installed and put into operation a factory in Barcelona, Spain, for the manufacture of the Maxim incandescent lamp, and introduced incandescent electric lighting into Holland by installing the Maxim system in the gas works of DeBruyn and Zonen, Amsterdam. After his return to America, in 1882, he represented the United States Company at various expositions, including those held at Cincinnati, Louisville, Charleston, etc. In 1887 he severed his connection with this company and located in Detroit as general manager, first of the Thomson-Houston Electric Light Company and later of the Brush Electric Light Company, which latter position he held until 1890, when he entered the electric railway field in the service of the Detroit Electrical Works, of which company he was elected secretary a year later. He held that position until the organization of the Michigan Electric Company about two years ago, of which company he is president. Mr. Lockwood is a regular attendant at the conventions of the National Electric Light Association and the



Jos. E. Lockwood.

Geo. A. Mansfield.

American Street Railway Association, and his face is a familiar and welcome one to the members of both associations. Geo. A. Mansfield, who is associated with Mr. Lockwood as treasurer of the Michigan Electric Company, is a graduate of the Michigan Military Academy and afterwards attended lectures at the University of Michigan. During the past two years he has been an indefatigable worker in the electrical supply field, in which he has acquired an influential position.

Trade and Industrial Notes.

MR. H. F. TATE has been appointed Western manager of the National Conduit Company, New York, with an office at 542 The Rookery, Chicago.

THE ADAMS ELECTRIC MANUFACTURING COMPANY, Elkhart, Ind. reports night work a necessity in order to meet the increasing demand for its transformers.

ERNEST F. ROBBINS, Burrville, Conn., in a 116-page catalogue describes a number of lathe attachments and tools of his manufacture, designed to facilitate operations and cheapen cost.

THE GISHOLT MACHINE COMPANY, Madison, Wis., in a nicely gotten up pamphlet of 16 pages entitled "Modern Turret Lathe Practice," issued monthly, describes and illustrates its own manufacture.

ANY COMPANY contemplating underground work will do well to call on Mr. McQuaid or Mr. Tate, of the National Conduit Company, at the Hollenden Hotel during the convention, and get some "interior lining.

THE PHILADELPHIA ELECTRICAL AND MANUFACTURING COMPANY, corner Twentieth and Jones streets, Philadelphia, has issued a very neat pamphlet and price list illustrating a number of arc light specialties which it is putting on the market.

THE C. W. HUNT COMPANY, 45 Broadway, New York, reports eminent success in the equipment of lighting and power stations with coal-handling machinery. Those interested in the economical handling of coal and ashes will do well to obtain some of the useful literature on the subject published by this company.

WARREN WEBSTER & COMPANY, Camden, N. J., are distributing copies of a handsome illustrated catalogue of the Webster "Vacuum" feed-water heater and purifier, Webster steam-separator, and Webster oil-separator. The book also contains numerous testimonials from parties using the Webster specialties. It is of convenient size and substantially gotten up.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., has finished the new gas house for the Bay State Gas Company in Boston. The building is 51 feet wide, 146 feet long, iron floor, iron roof, trusses, and iron purlins covered with slate. The same company has also lately completed for the Aqueduct Commissioners of New York City two iron bridges, one at reservoir M, the other at reservoir D.

THE ABENDROTH & ROOT MANUFACTURING COMPANY, 28 Cliff street, New York City, the sole makers of the Root improved water-tube boiler, will be represented at the convention by Mr. P. M. McLaren, and those of the electrical fraternity desirous of becoming better acquianted with the merits of the Root boiler for this special class of work will find him ready at all times to aid them in the matter.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has just published and distributed a copy of the rules and regulations of the National Board of Fire Underwriters in neat and convenient form for ready reference. Inasmuch as these regulations are now required in all the large cities, and a majority of the smaller ones, it is very necessary that every one in the electrical business should be familiar with them. It has also just completed a catalogue of electric railway supplies and will be pleased to furnish copies to the trade on application. In preparing this catalogue the Electric Appliance Company has made it consist wholly of electric railway supplies, not considering it necessary to pad it out with material which comes regularly under the head of electric light supplies.

THE FISHKILL LANDING MACHINE COMPANY, of Fishkill-on-the-Hudon, N. Y., is meeting with much success with the improved "Fishkill-Corliss engine," where close regulation and noiseless operation is desirable, as

for electric lighting and power plants. Representing in its construction the highest development in the "Corliss" type of engine it has the indorsement of the leading manufacturers and corporations in the United States.

THE ROYAL ELECTRIC COMPANY, of Peoria, Ill., reports the following sales of alternators, with an equal capacity in transformers, for the past month: Columbus, Neb., 1,250 lights; Roanoke, Ill., 500 lights; El Paso, Ill., 1,250 lights: Morton, Ill., 650 lights; Cambridge, Ill., 650 lights; Grand Haven, Mich., 1 000 lights; Raymond, N. H., 500 lights; Havana, Cuba, 500 lights; Los Angeles, Cal., 500 lights; Warsaw, Ill., 1,000 lights; Iowa Falls, Ia., 1,250 lights. A steady increase of transformer sales is also reported.

THE STANDARD PAINT COMPANY, at 2 Liberty street, New York, reports a steady demand for its P. & B. compounds, which have been favorably known to the trade for many years. The company also calls attention to a point frequently overlooked, namely, that the disagreeable odor emitted by these compounds when first applied disappears as soon as the paint dries. It is also claimed that the odor referred to is a necessary accompaniment of the highest grade of insulating ingredients, and is, therefore, an indication of the quality of the product.

W. C. STERLING & SON, Monroe, Mich., report that they are getting out a large number of cedar poles in Northern Michigan, notwithstanding the extremely cold weather at the different cedar camps. Poles are being piled up along the Au Gres and Rifle River, and in the early spring these will be rolled onto the ice in the river to be carried down to the lake, where they are rafted to Monroe. The sleighing is so good in the forests that the pole yards on the railroad are becoming well stocked, and a large trade is looked for in the early spring. The market for telephone poles has been very good this winter. Since Sterling & Son made their consignment of poles to Buenos Ayres, South America, they have sent several car-loads to Texas.

THE ELSON & BREWSTER ENGINEERING COMPANY, 143 Liberty street, agents for the Belknap Motor Company, Portland, Me., reports business excellent, and that it has recently completed some very satisfactory contracts. This company superintended the entire electric and power plant in the building of Mrs. Frank Leslie, Bond street, also the entire power plant of the factory of Messrs. Sternau & Co., of Brooklyn, and recently installed the complete electric plant of one of the Hoboken ferry boats. Its moulding business is steadily increasing, the company having recently furnished the electrical mouldings required in wiring the American Express Building, 65 Broadway, the Fall River steamer Priscilla and the Brooklyn Bridge cars. An electric whistle was placed on the steamship City of New York by this company.

T. J. MURPHY & COMPANY, 126 Liberty street, New York, point with pride at the list of notable buildings equipped by them with switchboards, which includes almost every one of the modern structures that have in recent years added so much to the architectural glory of New York. Their work, however, has not been confined to one vicinity; in Philadelphia, for example, they equipped among others, the great Betz and Drexel buildings, and we note that the magnificent Ponce de Leon Hotel at St. Augustine, in far away Forida, also benefitted from their services. One of the reasons for the success met with by this firm is their ability to design switchboards to suit the exact conditions of a given case, however restricted they may be in regard to location or however elaborate the surroundings. All of the mechanical work is designed and executed in accordance with the best electrical principles as regards insulation and safety, and, if desired, the finish is made to accord with the trim or decorations of the building, or a special artistic form given.

Business Notices.

WOVEN WIRE BRUSHES.—The Belknap Motor Company, of Portland, Me., are the patentees and manufacturers of the best woven wire commutator brush on the market.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED FEBRUARY 12, 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

11,471. FIRE ALARM APPARATUS; Samuel W. Ludlow, Madisonville, O. App. for re-issue filed Jan. 19, 1895. In a fire alarm, the combination of air or gas pipes, an alarm-actuating device operating by pressure, connected to the pipe, and a thermostat for creating the pressure consisting of an expansible medium normally inactive till application of heat thereto and in communication with the pipe, and when expansion takes place adding its volume to the contents of the pipe to cause the pressure necessary to actuate the alarm.

533,861. ELECTRIC LOCOMOTIVE: Eben M. Boynton, West Newbury, Mass. App. filed April 9, 1894. In a single rail, supported railroad car the combination with the car body of a frame fastened to same near one end thereof having guide wheels engaging with an upper guide rail, a driving wheel having removable web plates fastened to hubs revolving loose on a shaft situated in the frame, armature and field magnet elements situated between the web plates and one element fastened to the wheel tire and the other element to the shaft and means for fastening the shaft to the motor frame or allowing it to rotate.

533,869. CONDUIT SYSTEM FOR ELECTRIC RAILWAYS; Fred. S. Davenport, Jerseyville, Ill. App. filed Oct. 26, 1894. The combination with a feed wire and traveling contact bar, an underground conduit having for one of its sides one of the track rails secured to the laterally projecting base of the opposite side, the top of the latter being surmounted by a removable cover adapted to shelter and protect the feed-wire and contact bar.

533,873. ALTERNATING CURRENT DYNAMO ELECTRIC MACHINE; Axel Elstrom, Lynn, Mass. App. filed July 26, 1894. In an alternating current dynamo electric machine and in combination coils carried upon a revolving armature, one terminal of such coils connected to collecting rings and the other terminal to a commutator, and a shunt between one of the terminals, the collecting ring and the commutator.

33,877. RAILWAY SIGNALING APPARATUS; Chas. L. Fielder, London, England. App. filed June 13, 1894. The combination of a link motion, a friction pulley attached thereto, a locking blade on which the pulley travels, a distance piece restraining the blade when actuated by the electric current through an armature lever and a fixed guide block directing the movement of the distance piece.

533,885. APPARATUS FOR WINDING ARMATURE COILS; Henry Geisenhönor Schenectady, N. Y. App. filed Aug. 22, 1894. In an apparatus for winding coils for dynamo electric armatures, a curved supporting body part, and parts reciprocating therein and engaging the sides and ends of the coil.

533,893. ELECTRICAL EXCHANGE SYSTEM: Geo. W. Hey and Arthur E. Parsons, Syracuse, N. Y. App. filed March 30, 1893. Metallic circuits having corresponding wires normally connected together and their opposite wires normally disconnected, and an automatic switching device operated by current pulsations passed over one of the wires of the circuits for connecting the opposite wires together.

533,905. DISTRIBUTION SYSTEM FOR ELECTRIC RAILWAYS; Walter H. Knight, Schenectady, N. Y. App. filed Nov. 30, 1894. In an electric railway, the combination of a trolley wire and section insulators dividing successive portions of the trolley wire into insulated sections, with circuit connections coupling such successive sections of the trolley wire respectively to the positive and negative branches of a three-wire distributing system.

533,910. TIP FOR ELECTRIC CONDUCTORS; Amandus Metzger, Schenectady, N. Y. App. filed Nov. 26, 1894. A conductor tip formed of a single piece of metal comprising a flat portion doubled upon itself, and a tube formed integrally with the flat portion for embracing the conductor end.

533,913. FUSE BLOCK AND SOCKET; Fred. W. Mount, St. John, Canada. App. filed July 16, 1894. A fuse block provided with a hollow metallic bushing having a screw threaded end, in combination with a socket screwed to the extended end, and insulated fusible conductors passing directly from the fuse block into the socket.

533,919. SYNCHRONIZER FOR CLOCKS; Henry S. Prentiss, Elizabeth, N. J. App. filed June 30, 1892. The combination of a master clock constructed to close the circuit at a predetermined period before the hour and to break it at the hour, and a secondary clock provided with a separable connection between two operative parts of the train, an electromagnet controlling the connection, a detent for arresting the movement of the train when in a predetermined position, and a circuit closer operated by the train and set to close the circuit through the electromagnet in advance of the closing of the circuit at the master clock, and to break it simultaneously with the closing of the circuit at the master clock.

533,920. SERIES PARALLEL CONTROLLER: Ed. D. Priest, Schenectady, N Y. App. filed Nov. 24, 1894. In a series parallel controller for electric motors a switch adapted to connect the motors in various combinations, series, multiple series, or multiple, and a reciprocating resistance switch adapted to cut in resistance and open the circuit before each of such changes of combination.

533,926. ELECTRIC AUTOMATIC BLOCK SYSTEM SIGNAL: Jos. B. Stewart, Haverstraw, N. Y. App. filed March 8, 1894. In an electric automatic block signal system, the combination with the signal devices normally held to the danger position, of a normally open circuit comprising an electrically continuous rail, a series of electrically continuous rail sections, the sections being insulated from each other, a series of batteries having like poles connected to the electrically continuous rail and their other poles connected to one end of the sectional rail and a relay connected to the adjacent ends of two sectional rails.

533,930. ARMATURE WINDING; David P. Thomson, Schenectady, N. Y. App. filed Aug. 4, 1894. In a dynamo-electric machine, a armature coils and commutator segments, the segments cross-connected to the coils by leads of equal lengths.

533,931. DYNAMO ELECTRIC MACHINE; Elihu Thomson, Swampscott, Mass. App. filed Dec. 29, 1890. A method of regulating a dynamo for constant potential under increase of speed, consisting in increasing the speed of a separate generator more sensitive to speed changes, and using the increased current of such generator as a generated counter magnetizing force on the main.

533,932. CARBON FOR ARC LAMPS: Elihu Thomson, Swampscott, Mass. App. filed Nov. 26, 1894. A carbon for arc lamps, comprising an outer casing or shell of hard carbon and an inner core of softer material, the inner core being cut away from the tip of the electrode.

533,936. ELECTRIC BATTERY; Jas. M. Wells, Peoria, Ill. App. filed July 31, 1893. The combination of an inclosing case having its interior divided into two compartments, one of which is adapted to contain a suitable battery fluid by a partition of insulating material, a support pivotally connected to the shell, an induction coil arranged in one of the compartments of the shell and adapted to be connected with suitable electrodes, a metallic pin

carried by the insulating partition and having one end in contact with the core of the induction coil and its other end projecting into the compartment containing the battery fluid, a positive battery element secured on the projecting end of such pin, a metallic plate secured to the insulating partition and electrically connected with the helix of the induction coil, and attached to the plate.

533,938. SEMAPHORE FOR RAILWAY SIGNALS; David H. Wilson, Chicago, Ill. App. filed April 28, 1894. The combination of an electromagnet, and armature for the same to which is attached a tube containing mercury and having the air exhausted therefrom, contacts sealed to the ends of the tube, a semaphore and connections between the semaphore and the armature, whereby the semaphore is vibrated while it is acting as a signal.

533,967. COMBINED TELEPHONIC AND TELEGRAPHIC SYSTEM; Chris. A. Shea, Boston, Mass. App. filed July 30, 1892. The combination with line wires of a metallic circuit, and independent telegraphic instruments for each line wire, of a telegraph or telephone converter, each terminal of which has a separate connection, outside of telephone coils, capable of transmtting electric impulses, with each line wire.

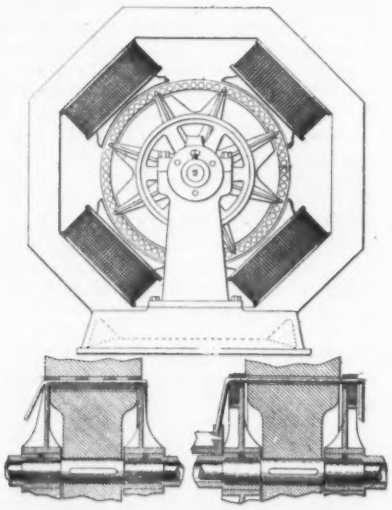
533,979. ELECTRICAL TIME ALARM; Walther Wilke, Wermelskirchen, Germany. App. filed Aug. 7,, 1894. The combination of the arbor, hub mounted thereon, insulating packing on the conoidal end of the hub, the conoidal shell fitting on the packing, a hand carried by the shell, contacts arranged to be successively touched by an attachment of the hand as the letter is carried around by the arbor, and circuit wires making connection with the shell and the contacts.

534,021. ANGULAR PIPE SECTION; Fred. A. Swan, Boston, Mass. App. filed Aug. 8, 1894. This comprises two members at an angle to each other and an anti-friction device loosely mounted within the angular pipe section.

534,025. AUTOMATIC TELEGRAHING MACHINE. Chas. E. Yetman, Oak Park, Ill. App. filed Dec. 2, 1893. The combination with the rotating driver and with the reciprocating shifter controlled by the character key of the circuit make and break ring interchangeably supported at its inner rim upon the driver and alternately at its outer rim on the shifter.

534,036. GALVANIC BATTERY; Warren P. Freeman, Brooklyn, N. Y. App. filed June 11, 1894. A box having imperforate walls and containing a number of cells, a flanged tray placed in or upon the top of the box, a cover applied to the top of the tray and forming with the tray a sealed chamber, electrode connections within the chamber, a pocket in the under side of the tray above each cell, a carbon connected at its upper end to the tray within each pocket, and a zinc electrode in each cell; the pockets being filled with a sealing compound around the upper ends of the carbons to prevent the upward escape of acid fumes.

534,038. DYNAMO ELECTRIC MACHINE; Rodolphus Fuller, Detroit, Mich. App. filed Oct. 20, 1894. The combination of an armature shaft, two commutators thereon on opposite ends, and double windings upon the armature comprising a number of separate turns of wire connected to the two commutators in alternate order.



No. 534,079.—Dynamo Armature.

534,060. ELECTRIC CONTROLLER; Geo. F. Card, Covington, Ky. App. filed May 17, 1894. In an electric controller, a shaft; a non-conducting sleeve embracing the shaft; a series of cams mounted on the sleeve, a cut-out mechanism adapted to be actuated by the cams and means for rotating the shaft.

534,078. REGULATING DEVICE FOR CAR MOTORS OR OTHER ELECTRICAL APPARATUS; H. F. Parshall, Schenectady, N. Y. App. filed Dec. 11, 1891. The combination of the main shaft, switch apparatus moved thereby for controlling the motor, the second shaft parallel with the first and a reversing switch moved thereby, and an arm on the second shaft, which arm is locked or released by movement of the first mentioned switch.

534,079. ARMATURE FOR DYNAMO ELECTRIC MACHINE; H. F. Parshall, Schenectady, N. Y. App. filed Feb. 20, 1892. A stationary field magnet, a stationary armature core of iron but without magnetizing coils, and a rotating armature body consisting of an iron ring in the annular space between the field magnet poles and the stationary core, the ring being perforated, insulated conductors passing through the perforations and forming a drum winding for the armature. (See illustration.)

534,083. TELEPHONE METALLIC CIRCUIT; Chris. A. Shea, Boston, Mass. App. filed July 30, 1892. The combination of two main lines, a receiving instrument at each end included in both main lines, a transmitting instrument at each end connected with one only of the main lines, and, on the other a line, a balancing device at each end balancing the transmitting instrument at that end.

534,084. COMBINED TELEPHONE AND TELEGRAPH SYSTEM; Chris. A. Shea, Boston, Mass. App. filed July 3, 1892. The combination of a line wire, telegraph and telephone instruments connected therewith, a branch wire from the main line to the telephone core, and thence to earth, and an inductive resistance interposed to stop the passage along the branch wire of telephonic impulses between the telephone core and main line.

534,085. TELEPHONE METALLIC CIRCUIT; Chris. A. Shea, Boston, Mass. App. filed July 30, 1892. The combination of two live wires between two stations, each wire being provided with means for transmitting and receiving an electrical impulse therealong, the means including at each end a core and a coil of the wire around it, with a third wire between the stations wound round the cores in succession in the opposite direction to the live wire round the cores.

534,086. ELECTRIC ARC LAMP; Thomas Spencer, Philadelphia, Pa. App. filed June 6, 1894. An arc lamp provided with movable carbon holders for its electrodes, independent pairs of conducting guides for the respective carbon holders, regulating mechanism for causing the mutual approach of the electrodes when the lamp is burning, and a plurality of movable elastically supported roller contacts mounted upon arms of carbon holders and engaging the guides.

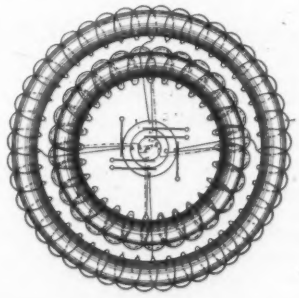
534,092. MEANS FOR MOUNTING DYNAMOS ON RAILWAY CARS; William Biddle, Brooklyn, N. Y. App. filed May 23, 1894. The combination with the car axle, of a sleeve permanently secured around the car axle and having a cylindrical portion forming a journal, a dynamo and dynamo frame having an oil box beneath the journal, a cap or box over the journal and screws for connecting the same to the dynamo frame, a dynamo bolted to the frame and gearing for connecting the axle and armature shaft of the dynamo.

534,151. ALTERNATING CURRENT MOTOR: Robert H. Hassler, Pittsburgh, Pa. App. filed Nov. 30, 1894. A method of starting alternating current induction motors which consists in subjecting the armature thereof to the combined inductive action of primary and secondary coils and decreasing the electromotive force in secondary coils as the speed of the movable member increases.

534,158. ALARM DEVICE FOR MILLS; Chas. L. Judge, Austin, Pa. App. filed Nov. 5, 1894. A pair of spaced upright contact posts included in a suitable alarm circuit, a pivotally supported oscillating lever carrying at one end a circuit closing bar working over the contact posts, a ball chute attached to the end of the lever opposite the circuit closing bar, a tube arranged under the lower end of the ball chute, and means for elevating weight balls from the tubes on to the high end of the ball chute to provide for overbalancing the end of the lever carrying the circuit closing bar.

534,206. FILAMENT FOR INCANDESCENT LAMPS; Thos. A. Edison, Menlo Park, N. J. App. filed Jan. 4, 1894. The process of making incandescent conductors for electric lamps, which consists in softening a horny animal substance in a suitable liquid, forming it into filaments and carbonizing same.

534,207. MANUFACTURE OF CARBON FILAMENTS; Thos. A. Edison, Menlo Park, N. J. App. filed Dec. 27, 1886. A group of covered receptacles or carbonizing boxes for incandescent lamp filaments, the several boxes being placed one above another and having covers on which are standards or projections which support the boxes above it.



No. 53,208.—Induction Converter.

534,208. INDUCTION CONVERTER; Thos. A. Edison, Llewellyn Park, N. J. App. filed May 21, 1888. In an induction converter, the combination of a stationary field coil and a stationary armature with two coils, the field coil and one armature coil being connected in multiple arc to a source of current by means of commutators, and the second armature coil being connected to the consumption circuit. (See illustration.)

534,209. INCANDESCENT ELECTRIC LAMP; Thos. A. Edison, Llewellyn Park, N. J. App. filed Sept. 17, 1890. In an incandescent electric lamp, the combination with the glass stem or wire support of leading in wires passing through the same and held therein by the fusing of the glass tube upon them, and each composed of an outer covering of readily fusible metal or alloy and an inner core or base of metal of comparatively high fusing point.

534,238. SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; Malone Wheless, Washington, D. C. App. filed Dec. 3, 1894. A track terminal holder comprising a socketed receptacle formed with a passage below the socket for the connecting wiring of the terminal in combination with a non-conducting block seated and held in the socket, a track terminal pin passing up through the block, and a contact cap seated on the block and detachably connected to and covering the upper end of the terminal pin.